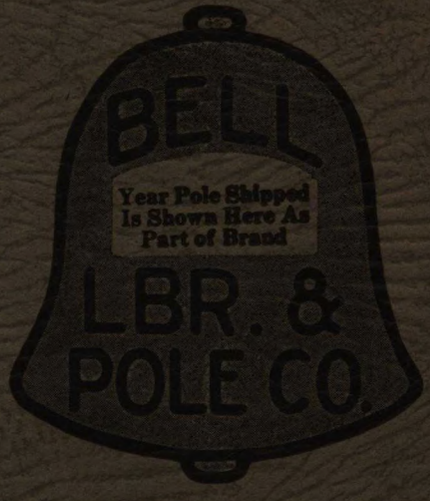
CEDAR POLES
CATALOGUE

Valuable Information Inside

Western Red
CEDAR



Northern White
CEDAR

Above "Bell Brand" Burned on the Side of Every Pole
at a Point 4 Feet Above Ground Line.

BELL LUMBER & POLE CO.

Minneapolis, Minnesota

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Manufacturers and shippers to the trade of all sizes and lengths of treated and untreated cedar poles.

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MAIN SHIPPING YARDS AND TREATING TANKS AT
Minnesota Transfer, Minnesota—Other Seasoning and Shipping Yards in Idaho, Washington and British Columbia.

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Foreword

THIS Catalogue is dedicated to the presentation of data of particular interest to those upon whom rests the responsibility of a sustained service efficiency of Public Utility outdoor plants, or in whom is invested the authority for, and the duty of, materials selection and construction design of Electric Power, Telegraph and Telephone Transmission and Distribution Lines.

It is our purpose to exhibit, as well as can be done through the medium of the printed word and picture, the specific advantages attendant upon the use of Cedar Poles for line replacements and construction, to the end that there may be a continuing and increasing use for that particular wood pole specie, proved by actual field tests and laboratory research to be Nature's best contribution to the outdoor plant of the Public Utility—the Long Span High Altitude Western Red Cedar Pole.

Linemen and yardmen, the personnel of Engineering and of Purchasing Departments, will find the tables and other general information of much value in connection with their work. We respectfully urge their careful and earnest meditation of the statements contained herein, all of which are based upon the accumulated knowledge of almost a half-century practical experience, combined with that knowledge acquired through the medium of Research Laboratory, Experience Data, and from other affiliated sources.

A compilation of useful and reliable tables, specifications and other data, presented with the belief that practical information of this kind is of general interest and an inestimable aid in the efficient operation of large and small utility alike.

Table of Contents

Introducing the Company's Executive Personnel

THE above group, comprising the "official family" of the Bell Lumber & Pole Company, has an experience background of many years activity in the production, manufacturing, preservative treating and marketing of the products of the Pole, Piling and Tie Industry. Headed by M. J. Bell, Sr., who first began activity in the industry through the production of forest products back in 1888, each member of the staff is in charge of a separate department within the organization and for the management of which he has been especially trained—yet the requirement that each individual have thorough knowledge of all branches of the business has builded an organization in which co-ordination of the functions of each department with those of another department has created an efficiency of enviable value from the standpoint of the pole user.

Western Red Cedar Poles For Utility Use

THE ability and the capacity of poles produced and manufactured from Western Red Cedar timber to give service performance in Transmission and Distribution lines beyond the possibilities of poles produced from other species of timber has been adequately proven by the actual experience records of utilities during recent years, and the now almost universal recognition of its true value is based entirely upon those outstanding qualities that make it so strikingly superior.

For a number of years prior to the adoption of standard specifications covering the various competitive wood poles, by the sub-committee of the American Standards Association (standard specifications were approved by that Association June 20th, 1931, and were adopted by the Associations representing the cedar pole industry March 4th, 1932) some of the cedar pole companies, through special departments set up for the purpose, conducted broad and extensive tests and engaged in exhaustive research to secure complete, authentic and indisputable information on the adaptability of Western Red Cedar for Utility use; some Utilities, too, particularly the larger electric power and telephone organizations, through field activity and laboratory experiment, carried on broad investigation, and resulting information was greatly augmented by the painstaking and exhaustive work of the Western Red Cedar Association Research Division.

Since the American Standards Association specifications were adopted as standard, and since these specifications placed poles of all timber species falling within the requirements of specific classification on a uniform strength basis, there has been accelerated activity, on the part of some of the producing and marketing units in the cedar pole industry, in the accumulation of further information which has brought out pertinent and important facts which may properly be defined as "basic qualities" which are:

1. *Average circumferences are substantially larger than required minimums.*

2. *Cedar poles are exceptionally stiff per unit of weight.*

3. *Season checks are not harmful to the strength of cedar poles.*

4. *Cedar poles are naturally resistant to decay and insects.*

5. *Cedar heartwood has an abundantly proven natural durability.*

6. *Protection of cedar is needed only for the sapwood in the ground line area.*

7. *Untreated cedar lines show long life of tops.*

In addition to the qualities enumerated it has been determined there are other characteristics of Western Red Cedar Poles that are such important factors in establishing their real worth for transmission and distribution line construction that they have been set up as "plus qualities" under the following designations:

Stability—

Cedar's low center of gravity gives greater stability than is possible in the use of poles of competitive specie; this greater stability means less straightening and guying.

Light Weight—

Cedar poles weigh 30 to 40 percent less than do either the fir or pine species; this lighter weight lowers transportation and construction costs.

Adaptability—

The use of cedar facilitates construction work on poles; they are adapted for framing after placing in the line without risk of interior decay developing.

Conductivity—

The low electrical conductivity of cedar reduces operating costs; the insulating value of cedar is permanent.

Safety—

The use of cedar means less risk of electric shock; and, in comparison with competitive pole species, they are safer and easier to climb.

Appearance—

Cedar is attractive in appearance, an important factor in securing and maintaining public good will; cedar poles have no color limitations.

The following brief discussion of the above "basic" and "plus" qualities is in recognition of the need for emphasizing the principal reasons why utilities should choose Western Red Cedar Poles for use in transmission and distribution

lines in preference to poles from competitive timber species; it is proof that Western Red Cedar Poles come nearer meeting the requirements of the ideal pole than does any competitive species.

Average Circumferences Substantially Larger Than Minimum

When making selection of species for replacement or new construction use, and considering choice from the standpoint of strength, it is important to remember that the average circumferences of cedar poles of any given class will be considerably larger than the minimum specified for that class; this is particularly true of top circumferences, and very rarely, indeed, does it occur that a production operation will bring out poles measuring less than 19 inches top circumference, even though, under the specifications, a minimum top as small as 15 inches is permitted for the Class 7 and 17 inches is permissible for the Class 6 size. A tabulation of more than 33,000 woods-run Western Red Cedar Poles of all sizes, made by various pole organizations at the instigation of the Research Division, furnishes the following interesting data on top circumferences:

ASA Class No.	Minimum Top Circ. Allowed	No. of Poles Measr'd	Average Circum. Inches	Inches Over Minimum
7	15	5,281	20.59	5.59
6	17	6,274	21.83	4.83
5	19	8,039	24.04	5.04
4	21	6,323	25.93	4.93
3	23	4,008	27.06	4.06
2	25	2,016	28.02	3.02
1	27	1,085	29.29	2.29

Cedar Poles Exceptionally Stiff Per Unit of Weight

Because Western Red Cedar Poles, before being put into use, are subjected to air-seasoning over a period of several months, they have the stiffness and other characteristics of dry wood, and this condition, together with their larger diameter, causes them to be considerably stiffer than poles of competitive species. The new pine and fir poles, with an interior moisture content well over the fibre saturation point, have as little resistance against bending at the time of going into the lines as does freshly cut green timber.

This difference between the cedar and pine poles was strikingly shown in a comparison of seven test poles of each specie, of the same length, class and top size and of the same average ultimate breaking load; the cedar poles showed an average top deflection of only 5.8 feet, while the average deflection of the pine poles was 12.86 feet.

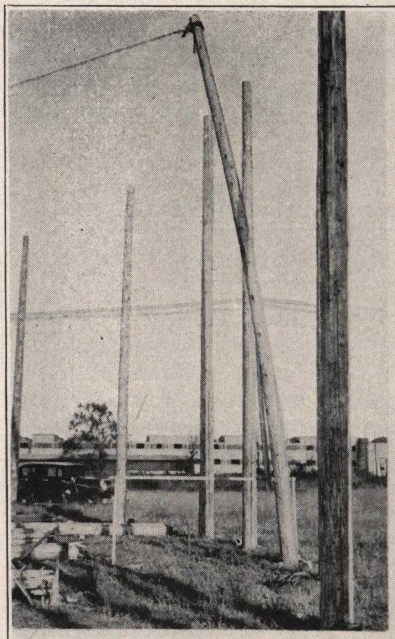
Season Checks Not Harmful to Strength of Cedar Poles

Because of the natural stresses set up during the seasoning or drying out process after they have been cut from the stump, all round timbers such as poles must check more or less on the surface, as the wood, in drying, is subjected to those stresses through shrinkage. Checks in cedar poles are usually inconspicuous, but it sometimes happens that exposure to extraordinary conditions causes larger checks than are normally found.

To determine the effect of checks upon the strength of the cedar pole some very interesting tests were made and developed that the presumed damage is more apparent than real. These tests were on a considerable number of badly checked poles, some of them with continuous checks from one end to the other, and which had been designated as culls because of their exceptionally checked condition. All poles tested showed strength values well in excess of the standard requirements for Western Red Cedar Poles under American Standards Association specifications, and no relation was shown between the checks and the type of fracture in the pole. All poles tested broke at the ground line, irrespective of checks, fractures being in compression of the fibers on the pull side and in tension of the fibers on the opposite side.

Since it has been established that checks do not destroy but merely separate the wood fibers, such separations are no more harmful in a wide check than in a narrow one, and the full fiber strength is retained in both cases. The only way a check could reduce the bending strength of a pole would be by failure in shear, along the plane of the check, and since extensive tests show that such shear failures do not occur, it is evident that season checks, regardless of width or length, do not weaken a cedar pole in any way.

Test of Checked and Rejected Western Red Cedar Class 6-35'



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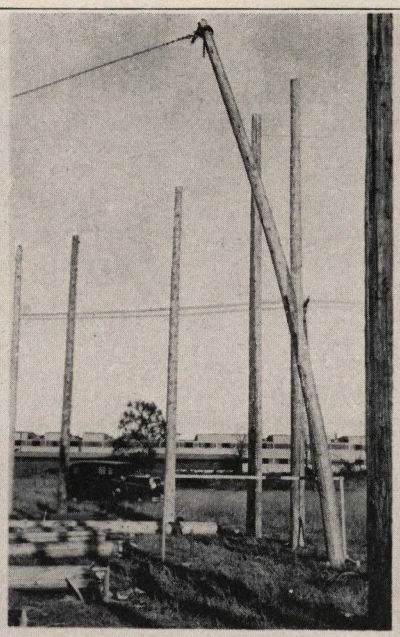

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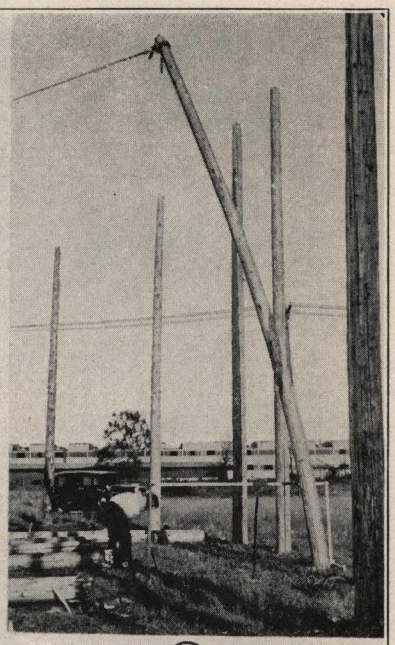

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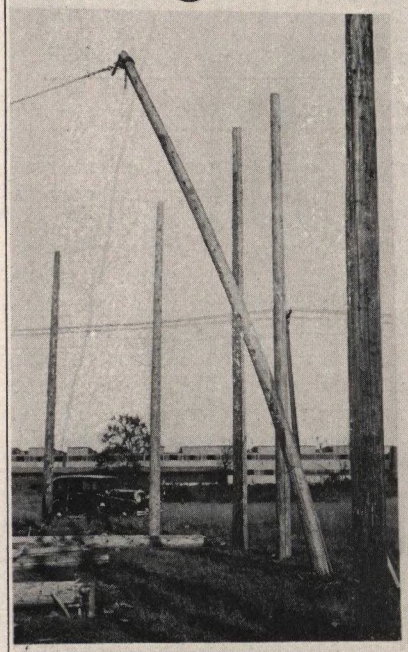
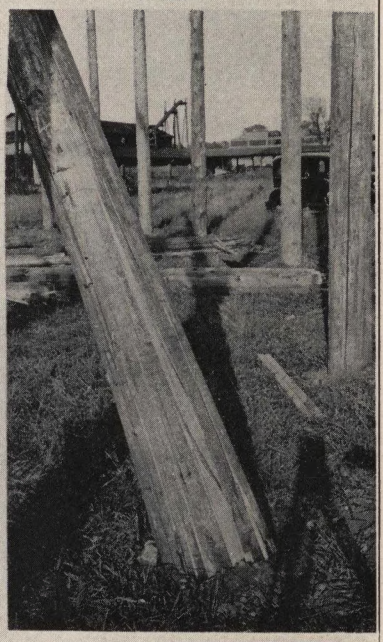


(4)

1. At 1,250 lbs. top load. Top deflection 5 feet.
2. At 1,650 lbs. top load. Top deflection 7 feet 4 inches.
3. At 1,850 lbs. top load. Top deflection 8 feet 10 inches. Reached elastic limit at 1,900 lbs.
4. At 1,350 lbs. top load after elastic limit.
5. Butt of pole at complete failure.

Ultimate moment of resistance at ground line 53,992 foot-pounds.

Modulus of rupture 6,850 lbs. per square inch.



(5)

This pole failed in tension and compression together with some vertical shear, at the ground line. Vertical splits all new and not along checks.

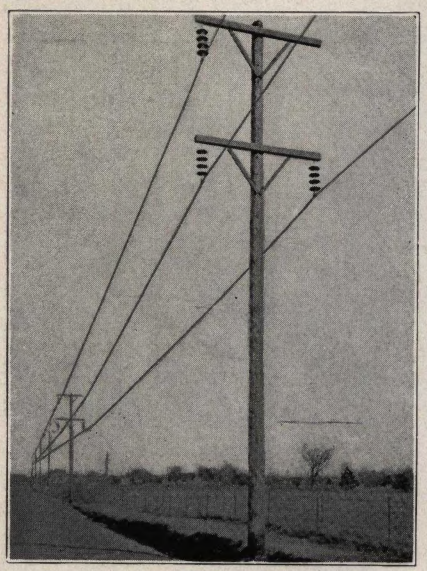
The largest check in this pole was 17 feet long, 3 inches deep and 3/8-inch wide. This check was in the "shear" position, that is, the check plane was at right angles to the direction of the pull.

The Fracture Showed No Relation to the Checks

(Photographs printed through courtesy of the Research Division, Western Red Cedar Association)

Strength of Cedar Proved by Long Spans In Transmission Lines

It is apparent as the result of their performance in spans of more than 1,000 feet in transmission lines in particularly hilly and rugged country, that Western Red Cedar Poles have an abundant and adequate strength. Years of service in these long spans, under conditions of severe exposure, haveshown conclusively that cedar poles are well adapted to give satisfactory service under the heaviest loading for which wood structures have been used. Experience with more than 20 million Western Red Cedar Poles, in all parts of the country and in every kind of overhead construction, gives overwhelming proof of their ample strength when properly treated and intelligently used.



Minimum and Average Breaking Strength

Ultimate Fiber Stress In Lbs. Per Square Inch

ASA Class	Class Min.	Class Av.	% Incr.
7	1,200	1,350	12.5%
6	1,500	1,700	13.3%
5	1,900	2,150	13.2%
4	2,400	2,700	12.4%
3	3,000	3,350	11.7%
2	3,700	4,100	10.8%
1	4,500	4,950	10.0%

It is seen from the figures in the table on Page 6 that the average run of cedar poles is substantially larger than the ASA minimum, both in top and ground line circumferences. The significance of this is that the user is thus provided with an extra factor of safety of very decided value in providing against any abnormal stresses arising under exceptional conditions. The designer can choose the minimum size of pole that will meet normal service needs with assurance that the average strength of the line will be higher than this minimum. Engineering departments will do well to keep this in mind, for it is often possible to use one class smaller than might otherwise be used, and in this way make a material saving in first cost.

Cedar Poles Naturally Resistant to Decay and Insects

It has long been recognized that the heartwood of Western Red Cedar is one of the most durable of woods. It has a high resistance to the attacks of both wood-rotting fungi and wood-boring insects. A partial explanation of this natural durability has been furnished by a chemical analysis of the extractives from the heartwood. It has been found that this heartwood contains a toxic phenol compound that is more poisonous to decay organisms than is mercuric chloride, of which it requires only one part in 10,000 to kill wood-rotting fungi; and, too, the essential oils in cedar heartwood are known to be obnoxious to wood-destroying insects.

Natural Durability of Cedar Heartwood Abundantly Proven

There are millions of untreated Western Red Cedar Poles that during forty years and more of large-scale use have given an average service life of from 12 to 15 years for the smaller sizes to more than 30 years for the larger sizes. In western forests, full grown trees, more than 300 years old, are frequently found growing with their roots astride fallen cedar trees in which most of the heartwood is still sound and usable, in spite of the ideal conditions for decay. This same natural durability is a dependable characteristic of the heartwood of all Western Red Cedar Poles.

Protection Needed Only for Sapwood at the Ground Line

Through records accumulated during an experience extending over a period of almost half a century, augmented by the facts developed through the field tests, laboratory research and chemical analysis of recent years, it is now a recognized fact that insofar as cedar is concerned protection for the pole timber, against the development of wood-rotting fungi, it needed only for the sapwood in the ground line area, at which point the

pole in use is exposed to the three essential elements conducive to fungi growth—moisture, heat and dirt. Above the ground line the sapwood of the cedar pole is amply capable of taking care of itself in combating decay, through the simple characteristic of rapidly drying out after rains, a process which maintains a sapwood moisture content more than sufficiently low to prevent fungi growth.

Untreated Cedar Lines Show Long Life at Tops

Examinations of many old untreated cedar lines throughout the consuming territory have shown a survival of from 50 to 90 percent in the large-sized poles after 28 to 35 years continuous use. The smaller sizes, such as those utilized in telephone and telegraph lines, naturally, have not made quite such a record, particularly because of their smaller percentage of heartwood at the ground line. A uniform characteristic of all of these old lines, both large and small, has been the long life of the above ground portion of the poles. Even in the oldest of lines, after 30 years or more of exposure, the upper portion of a great majority of the poles has been found to be practically as sound and serviceable as when they were new poles and were first placed in the lines.

Cedar's Low Center of Gravity Gives Great Stability

In addition to the basic qualities of strength and durability which any pole must have to a reasonable degree, cedar poles have a number of "plus" qualities, not found in poles from most other competitive wood species, which add materially to the advantages of cedar for overhead structures. Cedar poles show a marked ability to stay in the ground and remain upright when exposed to high winds and to other transverse forces. This is due to their low center of gravity and their comparatively larger butt circumference. The butt wood of a cedar pole is much heavier than the wood of the top and this greater weight in the butt is increased by the added weight of many pounds of creosote per pole used in butt treatment. Cedar poles will remain in position under conditions of soil and exposure where the more slender and top-heavy poles of competitive woods, especially the full length pressure treated poles, are apt to be pushed out of alignment or even pulled completely out of the ground.

Greater Stability Means Less Straightening and Guying

Because of their low center of gravity and large butt, as well as their great stiffness in resisting deflection, cedar poles require less guying than competitive types and cost less for realignment after windstorms, especially when set in wet and sandy soil in exposed locations. One Utility in a Middle Western state which owned a transmission line of poles of two specie of timber, found it necessary to realign the competitive poles seven times during the first two years, while the cedar poles did not require any straightening. Some pole users try to overcome this difference by setting the competitive poles one foot deeper in the ground, while others use additional guys. The use of cedar poles avoids these additional costs for construction and maintenance.

Untreated Western Red Cedar Poles in service in the lines of the Lake Superior District Power Company, Ashland, Wis., since 1902, and still carrying their load.

Cedar Poles Weigh Thirty to Forty Percent Less

Cedar poles of a given length and class weigh from 30 to 40 percent less than poles of competitive wood species. This means that 28 to 34 cedar poles can be hauled on a truck or trailer as easily as 20 of the competitive poles where weight is the limiting factor. This light weight is important where poles have to be piked into the holes by hand as the light weight of the cedar then becomes particularly valuable. In such cases the lower center of gravity of the cedar pole is a decided advantage.

One of the eastern states utilities reports finding that with the use of cedar poles a saving of from $2.00 to $15.00 per pole was effected in transportation and construction costs, depending upon length of haul and location of construction, as compared to the costs applicable to construction with poles from competitive wood species, the heavier poles requiring a gin pole for erection while the cedars could be piked into place.

Numerous other cases of substantial labor and transportation savings through the use of cedar have been reported. This is an important consideration in the economy of pole line construction and maintenance.

Use of Cedar Facilitates Construction Work on Poles

The clean surface and soft, uniform texture of cedar poles makes them easy to handle and to climb. The natural durability of cedar heartwood makes the cedar exceptionally well adapted for the cutting, boring and framing that must be done on wood poles in connection with construction and maintenance work. Attachment of cross-arms and brackets, fastening of braces and guys, installation of transformers, switches, and other apparatus, and leveling of tops are examples of the work that is often required on poles after treatment and erection. On cedar poles such work can be performed with a minimum of time and effort, and without danger of shortening the life of the pole by exposing the interior toxic heartwood.

Low Conductivity of Cedar Reduces Operating Costs

Tests have shown that under practically all service conditions cedar poles are characterized by a remarkably low electrical conductivity. Since the interior of a cedar pole is practically always in a dry, well-seasoned condition, and the surface is dry more than 90 percent of the time, low conductivity can be considered a normal property of cedar poles in service.

The resistance of cedar to the passage of electric current is not only high at the time of erection, but it is a stable characteristic actually increasing with seasoning; it is dependable and permanent. This reliable, low conductivity provides a valuable safeguard against electric shock to linemen doing "hot line" work. Such work can be done more rapidly as well as more safely on cedar than on poles of competitive species because of the higher and more dependable insulating value of the cedar wood.

Cedar Poles are Easier and Safer to Climb

The clean, smooth surface and soft texture of cedar poles and their large diameter make them easy and safe to climb; a lineman can "creep" up a cedar pole with very little effort, keeping his knees close to the pole and allowing his weight to sink his spurs in. In contrast, the hard and often pitchy surface of full length creosoted poles requires more effort to sink the spurs and often causes slipping, especially in colder weather. Linemen cannot be blamed for their preference for working on the safe and more comfortable cedar poles.

Cedar's Attractive Appearance Creates Good Will

There can be little difference of opinion as to the superior appearance of the straight, clean and symmetrical Western Red Cedar Poles, when compared with other species. This attractive appearance is an important factor in cultivating public good will and in postponing or avoiding the demand for expensive underground construction.

A cedar pole can be stained any desired color, including white. This is often an advantage, particularly in city construction or for special locations such as in the vicinity of airports or along public highways. Full length creosoted poles are largely limited to black, which is not desirable for many uses.

A few thousand new High Altitude Long Span Poles assembled from one of the Bell production operations awaiting shipment to our Minnesota Transfer Yards.

A Story in Pictures

Bell Lumber & Pole Company owns its own timber—thousands of acres of Cedar Forest in the interior High Altitude areas of the Rocky Mountains. Here it maintains its own production operations under personal supervision of an experienced woods superintendent in charge of crews especially selected for familiarity with the requirements of pole manufacture. Bell Poles are manufactured *IN THE WOODS right from the stump,* after which they are stored in adjacent seasoning yards to go through this process under influence of the climatic conditions of their native territory. The upper two pictures are views of Bell-owned cedar timber tracts; the center and lower right views show two of the adjacent seasoning yards; the lower left picture shows how poles are brought in, for seasoning, on one of the large trucks of the Bell operated fleet.

Bell High Altitude Western Red Cedar Long Span Poles

IN 1925, when it became necessary for our organization to seek and secure additional sources of Western Red Cedar Pole supply, action made imperative because of the rapidly increasing demand for Bell Quality and Bell Service, the attention of our timber experts was called to large tracts of cedar timber situated in the area known as the Sugar Lake District in the mountainous heights of the Selkirk Range forming the western portion of the Rocky Mountains in Southern British Columbia. Here was a vast tract of beautiful cedar timber growing under the most rigorous and severe climatic conditions—bitter cold, long winters, terrific winds, intense competition for sunlight, and short growing seasons—all of which combined to develop a strain of cedar unusually dense in wood growth, a specie of timber with exceptional strength and elasticity.

While making both the preliminary and final cruises of the area, much of which was under the personal supervision of M. J. Bell, president of the Bell Lumber & Pole Company, who has an experience background in this type of work covering almost a half century, it was observed there were certain, definite, outstanding qualities about the cedar in this tract of timber that stamped it as being distinctly different from the Western Red Cedar in other cedar growing areas. The trees had not grown to large diameters or great heights; they had a natural, even, perfect taper; there were no large, bulging formations in the branch sections; they were lacking in characteristically cedar timber sweep or kinks; in fact they were *natural* pole timber, with every tree making a *complete* pole, one pole to each tree and each pole with an exceptionally small number of branch knots. And it is from this type of timber that there has been brought to the utility market that specific type of cedar pole that well deserves designation as

Nature's Best Contribution to the Outdoor Plant of Power and Telephone Utility

While it has been said that "comparisons are odious," yet it is nevertheless true that "all things are good or bad by comparison," and it is when the advantageous characteristics of Bell High Altitude Western Red Cedar Long Span Poles are taken into consideration in comparison with poles coming from competitive timber species or from other cedar producing areas, that *their superiority is accentuated and stands out in such sharp contrast.*

When considering the advisability of acquiring our present large holdings of High Altitude Western Red Cedar Pole timber, and for the purpose of determining if this particular specie of cedar had qualities of a superior nature for pole line uses, thorough tests were made of both the High Altitude and the Low Altitude timber, these tests being the result of our desire to produce the best Red Cedar pole that Nature made available. These tests turned out so emphatically in favor of the High Altitude specie that we had no hesitancy in making definite decision. The tests were made by the Canadian Forestry Laboratories at Vancouver, B. C., and covered strength, growth habits, fibre structure, and study of all other essential characteristics such as rapidity of growth, weight, sapwood and heartwood content, and other factors important for consideration in making a decision.

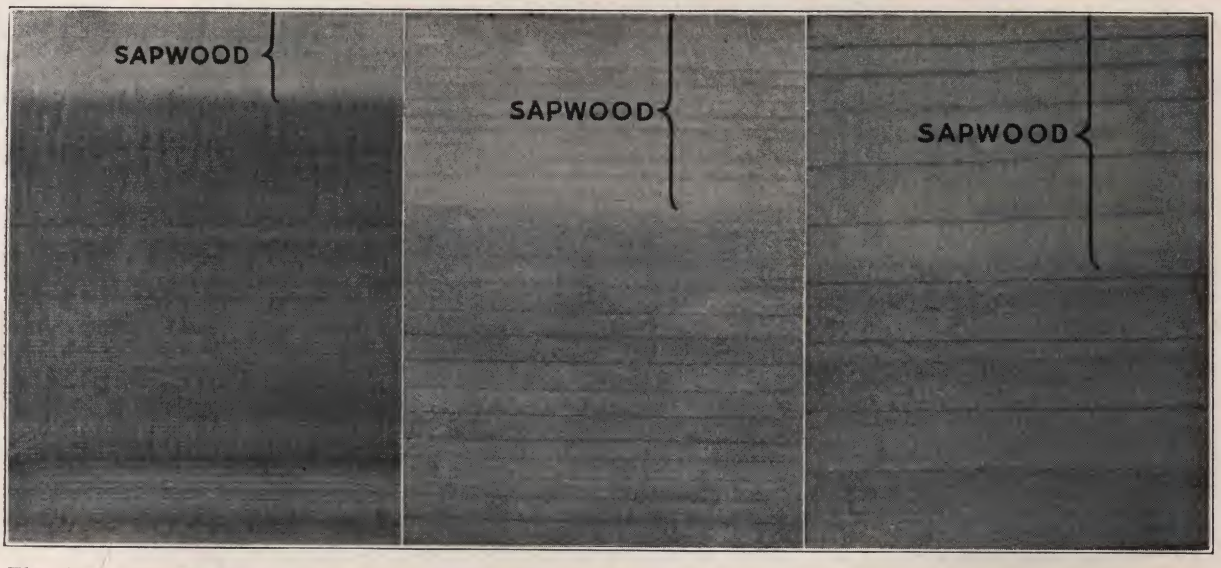
High Altitude Cedar Has Greater Strength

In making the tests poles of thirty foot length, produced from timber growth in both the High Altitude and the Low Altitude areas, were utilized, measurements being adjusted to a 7″ top diameter and a 9.6″ diameter at load. Relative to strength characteristics, sapwood content and average modulus of rupture, the tests resulted as follows:

	Average Applicable to High Altitude Cedar	Low Altitude Cedar
Sapwood	18%	27½%
Modulus of Rupture..	6,924#	5,895#
Min. Sapwood Depth.	1/6″	51/100″
Max. Sapwood Depth.	7/10″	1 1/12″
Aver. Sapwood Depth	2/5″	4/5″

By comparison, it will be observed, insofar as the results of this particular test are concerned, that the *average* sapwood thickness of the High Altitude Cedar Poles was less than the *minimum* sapwood thickness of the Low Altitude Cedar Poles. There will, of course, be some slight variations from these figures when all poles produced from any given area are considered; these variations, however, depend almost directly upon the amount of rainfall and the weather conditions prevailing during any one growing season in both producing areas, a long, dry season, or a cold season influencing the tree growth to an extent sufficient to greatly retard sapwood development. This is particularly true in the Low Altitude or Coast Region producing areas and causes greater variations to prevail in both heartwood and sapwood content of poles produced from the cedar timber of that particular area.

On the other hand, variations in climatic conditions are not nearly so often or so great in the High Altitude areas, and the result is that this particular specie of Western Red Cedar undergoes a development each year that is decidedly



The above photographic reproductions show interesting demonstration of growth characteristics of Western Red Cedar as influenced by the climatic conditions prevailing at the altitudes of their particular growth areas. That on the left is of the slow growing, thin sapwood, tight fiber structured Bell High Altitude pole; in the center is the thick sapwood, more rapid growing Medium Low Altitude pole, while on the right is the thick sapwood, fast growing Coast or Extreme Low Altitude pole.

comparable to that of previous years, which is the reason High Altitude Western Red Cedar Long Span Poles are of *consistent* quality, year after year.

Cedar grows faster in the Low Altitude or Coast areas because of the longer, warmer growing seasons; in the High Altitude areas the growing season is very short and the climate is much colder. During the growing season the saliva between the bark and the wood of a healthy tree is continually forming into a new cycle of wood, and makes a complete new cycle, or ring, of wood each year. The growth rings will be larger after a long, warm season, with plenty of moisture, than they will after a short, cool, or dry season. The slower growing cedar from the High Altitude areas, because of the natural density of wood-fibre structure, is much harder and tougher than the cedar of the faster growing, Low Altitude variety.

High Altitude Cedar Poles Are Stronger

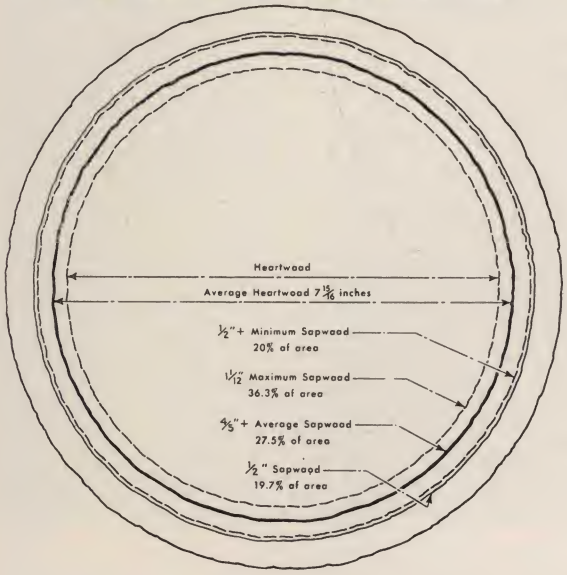
A Western Red Cedar Pole is from a timber specie built of minute, invisible particles of wood called "cells." They appear as tiny tubes with four sides or walls, are closed at both ends and contain water or air; they are commonly called "wood fibres." Only two kinds of cells or fibres occur in the wood of Western Red Cedar; one is spindle shaped, tapered at both ends. These cells are closely packed together and stand upright in a tree or pole, with the ends overlapping slightly. About 90 percent of the wood in a pole is of this kind of fibre. The other kind, making up the remaining 10 percent of the pole wood, are short, block-like cells, with square ends; these ends do not overlap but are joined end-to-end, something similar to the pattern of a brick wall.

All fibers in a pole are arranged by Nature in a very orderly manner, with great regularity and uniformity. In Western Red Cedar the heartwood and sapwood alike are constructed of these same fibers, and in the same way; all are securely cemented together, and never slip on each other in bending.

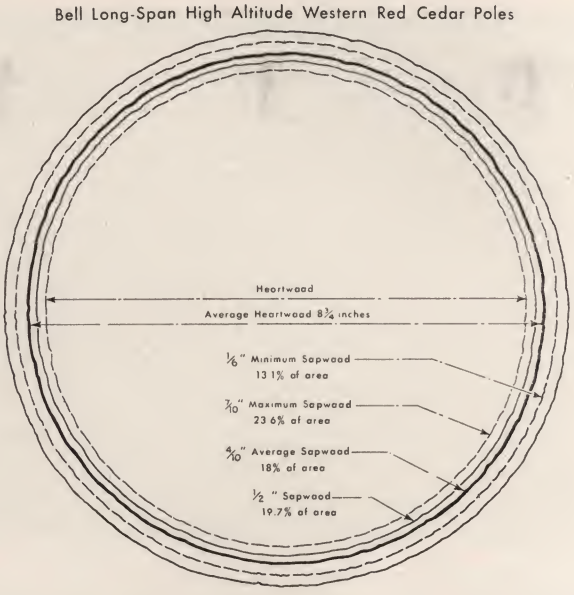
Strength, as used in terms of application to cedar pole quality, has really little definite meaning unless modified by such terms as compression, shearing, bending, etc. The universal method of construction in both the horizontal and vertical planes subjects structural materials, including timbers, to beam stresses and column stresses, or a combination of these, as in wood poles. Nature produces her timbers under these two general strength designations. Poles, set in the line, function as cantilever beams and also as columns, just as was done when they were still in the forest as trees before cutting.

Strength (fiber strength) is an important consideration in determining the value of poles for transmission line supports. And, *strength varies with density*—density of fiber or cell growth. There is one *direct* reason for the strength superiority of the distribution or transmission line

Low Altitude or Coast Region Western Red Cedar Poles



Bell Long-Span High Altitude Western Red Cedar Poles



pole taken from the slow-growing, close grained cedar timber of the High Altitude areas. There are many, many more of the closely packed, securely cemented fiber cells per cubical volume of wood in this specific type than in the Low Altitude or Coast cedar. Then, too, the mechanical properties peculiar to Western Red Cedar are accentuated, with much more of the resistance-to-shock elements per cubical volume than prevail in the pole from the Low Altitude or Coast timber.

High Altitude Cedar Poles Have Greater Service Durability

References to the sketches shown at the top of this page, and which have been drawn on the basis of measurements ascertained during the tests conducted by the Canadian Forestry Laboratories of Vancouver, B. C., determining the heartwood and sapwood content of poles taken from timber grown in both the High Altitude and Low Altitude or Coast areas, definitely demonstrates the superiority of the High Altitude type of cedar from the standpoint of durability in service. It will be observed that on these 30′ poles subjected to the test measurements (both types of poles being 9.6″ diameter at the load point) the average heartwood diameter of the High Altitude pole is 8¾″ as compared with an average heartwood diameter for the Low Altitude or Coast pole of 7 15/16″. In other words, all conditions of wood fiber and other characteristics of cedar being equal, *the High Altitude pole has longer life-in-service possibilities* proportionate to its greater diameter of heartwood over the heartwood diameter of the Low Altitude pole.

Considering the Low Altitude or Coast Region poles subjected to the test, with an average sapwood thickness of 4/5″ on each side, the pole having an original ground line diameter of 9.6″, losing its sapwood while in service, through age or other cause so that nothing remains at the ground line but the heartwood, it would then have a load-bearing diameter left at the ground line of only 8 inches. On the other hand, the High Altitude pole, in service originally with a ground line diameter of 9.6″, losing through deterioration its sapwood of 4/10″ on each side, would have a load-bearing heartwood diameter left of 8.8″, or 8/10″ more than the other pole.

Bell Ships 100% High Altitude Poles

The Bell Lumber & Pole Company does not claim there are no other pole producing or marketing organizations shipping High Altitude Western Red Cedar Poles to the utility market, but it *does* lay claim to being *the only concern in the cedar pole industry* that produces and markets exclusively the High Altitude specie of Western Red Cedar; all of the company's concentrated stocks are taken 100 percent through its own production operations, from its own timber holdings in the High Altitude area of the Selkirk Range district. All Bell poles are taken from timber tracts especially selected for their High Altitude cedar, and are cut from the finest grade of cedar timber in these tracts. Chosen particularly for appearance and durability in service Bell Long Span Poles are more than mere sticks of wood and trimmed cedar trees—*they are a manufactured article,*

the production of which is based entirely upon the actual experience gained through more than forty years "in the game."

Bell Poles Have Many Desirable Plus Qualities

Summing up briefly the definite "plus qualities" of the Bell High Altitude Western Red Cedar Long Span Poles, in comparison with poles taken from Western Red Cedar growing in other producing areas, they have

Greater Strength

Because of natural growth density.

Greater Shock Resistance

Because of more compact fiber structure.

Longer Life Expectancy

Because of the thinner sapwood in proportion to total cubical wood volume and greater proportion of naturally toxic, decay-resisting heartwood.

Requisites Of Perfect Pole

Because they possess extraordinary stability, are light in weight, have low conductivity, permit spans of greater length, carry heavier loads, have very even taper, are straight and possess unusual elasticity.

Every Bell Pole A Guaranteed Product

Bell High Altitude Western Red Cedar Long Span Poles offer construction possibilities that have not as yet been duplicated by poles secured from other cedar timber areas. Every pole shipped by the Bell organization is guaranteed, not only as to timber quality, but as to creosote treatment at the butt regardless of standard or individual specification requirements; and this guarantee is applicable to both our High Altitude Western Red Cedar Long Span Poles and our Northern White Cedar Poles. We maintain large, well assorted stocks of both cedar species, always in concentration, and available for shipment on particularly rush orders on 12 hours notice.

Proper Pole Seasoning Important

All Western Red Cedar Poles are air-seasoned, and, like any other process of pole production and preparation for line use, there is a right and a wrong way. The Bell organization has long recognized the outstanding importance of pole care during the seasoning process, the necessity of a method permitting, as far as is humanly possible, control of moisture evaporation during the seasoning period to the end that the stresses set up by Nature as the pole is drying are retarded sufficiently to prevent excessive surface checks. Strip-piling, which permits the free circulation of air around the entire pole, affords the necessary control and is a method that is standard in Bell production operations; and this *natural* drying protects the sapwood from decay and prepares the poles for subsequent use in a manner superior to any other air-seasoning method.

This picture demonstrates the care taken in seasoning poles in our woods operations. All Bell Long Span Poles are strip-piled for air-seasoning under influence of the climatic conditions to which they are native.

Bell pole quality is today the same high standard it always has been—straight, evenly tapered, close grained, bright, clean cedar poles—consistently the same and guaranteed to average better than specifications require. They embody all the desired requisites of the perfect pole—strength, reliability, durability. No pole is better—few are as good—and in consideration of economy and satisfaction, you can put your faith in Bell poles.

Preservative Treatment of Cedar Pole Butts

FOR more than thirty years cedar poles have been protected against sapwood decay and insect attack at the ground line through immersion of the butt ends in tanks of hot creosote oil. These treatments, starting in the early days with a process involving only brief dipping of the butt ends in the hot oil, have gradually developed, under the influence of tests and research, until today they comprise three distinct processes each of which is now conceded the maximum of efficiency for accomplishing the purposes desired of its specific type. These three processes are the so-called "AA Treatment," the "B Treatment," and the "Guaranteed Half-Inch of Full Sapwood Incising Treatment."

Observations and tests of poles in the line over a period of many years indicate the "AA Treatment" extends the life of the ground line sapwood for a period of 10 or more years (depending upon the conditions of use), the "B Treatment" extends the sapwood life at the ground line approximately 20 years, while the "Guaranteed Half-Inch or Full Sapwood Incising Treatment," through extensive field studies, indicates a ground line life expectancy of from 30 to 40 years. That this expectancy is justified is based upon the experience of more than 40 years with Western Red Cedar Poles in the lines of the principal power companies of the Pacific Northwest states.

Coal Tar Creosote As A Preservative

Because of its high degree of toxicity and the ease with which it penetrates the wood fibers, the most widely used preservative for poles in this country is Creosote; the most important creosotes for wood preservation are Coal Tar Creosote, Water Gas Tar Creosote, Wood Tar Creosote and Low Temperature Tar Creosote, with Coal Tar Creosote being the most extensively utilized in pole treating operations with the "open tank method" by which method cedar pole butts are subjected to the "AA Treatment," the "B Treatment" and the "Guaranteed Half-Inch or Full Sapwood Incised Treatment."

It has been determined through chemical examination that Coal Tar is comprised largely of hydrocarbons of the closed ring or aromatic series, including benzol, toluol and other tar acids, such as naphthalene, carbolic acid, anthracene, etc.

The Bell Lumber & Pole Company utilizes *only* guaranteed Creosote Oil in its open tank treating operations, and not less than once each month this Creosote Oil is subjected to laboratory toxicity test, the purpose being not only to maintain the Creosote Oil to American Wood Preservers' Association specifications, but to sustain a constant toxicity of 0.20 percent against fomes annosus—an extremely high killing power.

Fomes annosus is the Latin name of the fungus used as a standard in making toxicity tests, and the 0.20 percent is the killing concentration in the Creosote Oil sustained for the purpose of destroying the fungus. It is interesting to know that toxicity tests of Creosote Oil have determined it is necessary for the oil to have only 0.10 percent concentration to effect quite sufficient protection; in other words, the Bell Lumber & Pole Company sustains its Creosote Treating Oils on a basis twice the necessary concentration to insure ground line protection.

Preservative Specifications

The preservative used shall be a distillate of coal tar or coke-oven tar. It shall comply with the following requirements:

1. It shall not contain more than 3 percent water.
2. It shall not contain more than .5 percent of matter insoluble in benzol.
3. The specific gravity of the oil at 38 degrees C. compared with water at 15.5 degrees C. shall not be less than 1.03 percent.
4. The distillate, based on water free oil, shall be within the following limits:
   Up to 210 degrees C.—not more than 5 percent.
   Up to 235 degrees C.—not more than 25 percent.
5. The residue above 355 degrees C., if it exceeds 5 percent, shall have a float test of not more than fifty seconds at 70 degrees C.
6. The oil shall yield not more than 2 percent of coke residue.
7. The foregoing tests shall be made in accordance with the standard methods of the American Wood Preservers' Association.

A wide-awake and interested corps of employees operating the highest type of modern and efficient central station equipment, can render that desirable service demanded by a critical public only to the extent that transmission and distribution systems are maintained at the peak of load bearing capacity. Each individual pole must have adequate strength to sustain its portion of the load if the entire system is not to be disrupted. Build with Bell Poles and you put a permanence into your lines difficult to get with poles secured from any other source of supply.

Specifications for the Preservative Treatment of Cedar Poles

(Adopted March 4, 1932)

Condition and Preparation of Poles for Butt Treatment

Seasoning—Poles shall be satisfactorily air-seasoned under proper sanitary conditions.

Shaving—All inner bark shall be removed from the ground line area of the pole; i.e., that portion of the pole surface terminating one foot above and two feet below the standard ground line. The amount of wood shaved off in the removal of the inner bark shall be limited to a minimum.

Preservative—The preservative shall be a distillate of coal tar or coke-oven tar, commonly known as "creosote." It shall comply with the requirements as designated on Page 16 under the title heading "Preservative Specifications."

Treating Operations

Plant Equipment—Treating plants shall be equipped with thermometers to indicate and record accurately the temperature of the preservative during all stages of treatment. The apparatus and chemicals for making necessary analysis and tests shall be available for use by the purchaser or purchaser's representative. All equipment shall be maintained in good working order.

Handling—The use of any tools which might puncture the treated wood shall not be applied within one foot above or one foot below the ground line area.

Storing—Treated poles held in storage shall be piled upon treated or other non-decaying skids in a clean, well ventilated location free from vegetation and decaying wood. Skids shall be of such length as to support the poles without producing injurious distortion of any of them, and of such height that no part of any pole shall be less than one foot above the surface of the soil.

Length of Treated Sections—Poles shall be immersed in the preservative so as to completely cover the ground line area. The depth of immersion shall not exceed by more than two feet the height of treatment given in the following table. The table shows the relationship between the height of ground line and the height of treatment from the butt end of the pole.

Length of Pole	*Height of Ground Line*	*Height of Treatment*
16 ft.	3½ ft.	4½ ft.
18 ft.	3½ ft.	4½ ft.
20 ft.	4 ft.	5 ft.
22 ft.	4 ft.	5 ft.
25 ft.	5 ft.	6 ft.
30 ft.	5½ ft.	6½ ft.
35 ft.	6 ft.	7 ft.
40 ft.	6 ft.	7 ft.
45 ft.	6½ ft.	7½ ft.
50 ft.	7 ft.	8 ft.
55 ft.	7½ ft.	8½ ft.
60 ft.	8 ft.	9 ft.
65 ft.	8½ ft.	9½ ft.
70 ft.	9 ft.	10 ft.
75 ft.	9½ ft.	10½ ft.
80 ft.	10 ft.	11 ft.

Build with Bell Poles and you put a permanence into your lines that is mighty difficult to get with poles secured from any other supply source.

"AA" PROCESS TREATMENT

Fifteen Minute Hot Oil Immersion—No Specific Penetration Guaranteed

Poles shall be continuously immersed in the preservative at a temperature ranging between 215 and 230 degrees F. for a period of not less than fifteen (15) minutes.

"B" PROCESS TREATMENT

Four Hours Hot Oil, Two Hours Cold Oil Immersion—No Specific Penetration Guaranteed

Temperature and Duration of Hot Immersion—Poles shall be continuously immersed in the preservative at a temperature ranging between 215 and 230 degrees F. for not less than four (4) hours.

Temperature and Duration of Cold or Cooling Immersion—The preservative of the hot immersion may be allowed to cool in the treating tank, or it may be replaced with cold preservative. When the preservative of the hot immersion is replaced with cold preservative, the exchange must be complete within ten minutes.

When the preservative of the hot immersion is replaced with cold preservative, the pole shall be continuously immersed in the cold preservative for a period of not less than two hours and the temperature of the preservative for the entire period shall be between 150 degrees F. and the temperature at which solids form in the preservative.

When the preservative of the hot immersion is allowed to cool in the treating tank, the poles shall be continuously immersed in the cooling preservative at least two hours and until the temperature of the preservative has been reduced to a point between 150 degrees F. and the temperature at which solids form in the preservative. The poles shall then remain in the preservative at this

temperature for a period of not less than ten minutes.

"INCISED" PROCESS TREATMENT

Eight Hours Hot Oil, Two Hours Cold Oil Immersion—Guaranteed Half-Inch or Full Sapwood Thickness Impregnation

Incising—All poles shall be incised throughout that portion of the pole surface terminating one foot above and two feet below the standard ground line. The depth of incisions shall be ½-inch. A variation of 1/32 of an inch in the depth of the incisions shall be allowed. The sapwood shall not be splintered nor loosened by the incising operation. The pattern and spacing of the incisions shall be such as to insure a uniform depth of penetration of the preservative throughout the incised area.

Temperature and Duration of Hot Immersion—Poles shall be continuously immersed in the preservative at a temperature of 230 degrees F. plus or minus five degrees for not less than eight (8) hours and such period in addition thereto as will insure impregnation of the sapwood of the incised area with preservative to a depth of ½-inch. In case the sapwood of the incised area is less than ½-inch thick, the impregnation shall be for the full depth of the sapwood.

Temperature and Duration of Cold or Cooling Immersion—The preservative of the hot immersion may be allowed to cool in the treating tank or it may be replaced with cold preservative. When the preservative of the hot immersion is replaced with cold preservative, the exchange must be complete within ten minutes.

When the preservative of the hot immersion is replaced with cold preservative, the poles shall be continuously immersed in the cold preservative for a period of not less than two hours, and the temperature of the preservative for the entire period shall be between 150 degrees F. and the temperature at which solids form in the preservative.

When the preservative of the hot immersion is allowed to cool in the treating tank, the poles shall be continuously immersed in the cooling preservative at least two hours and until the temperature of the preservative has been reduced to a point between 150 degrees F. and the temperature at which solids form in the preservative. The poles shall remain immersed at this temperature for a period of not less than ten minutes.

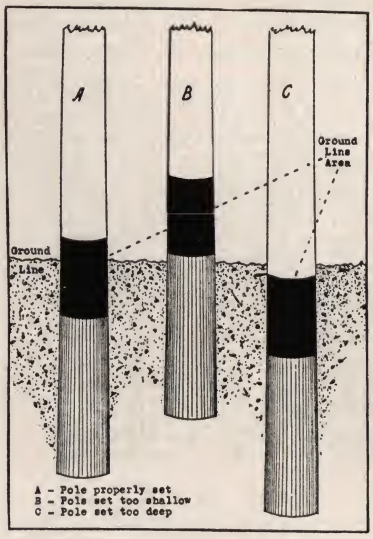
Impregnation—The results obtained under this specification shall be a uniform impregnation of the incised area with preservative to a depth of ½-inch, except where the thickness of the sapwood is less than ½-inch, in which case the impregnation shall be to the full depth of the sapwood. The depth of the impregnation shall be determined by testing with an increment borer at any point within the incised area. All such holes shall be filled with tight-fitting, thoroughly creosoted plugs.

Adherence to this specification results in not only the stipulated depth of impregnation, but also in a very large volume of preservative in the sapwood of the incised area, thus affording maximum protection against decay. No specific preservative content is mentioned owing to the difficulty of accurately making volume tests in the field. The presence of a large volume of preservative can be determined by observing the borings taken for penetration tests.

Proper Setting of Poles Essential

One of the very important factors for consideration in line construction is the proper setting of poles, if the maximum service durability is to maintain comparable to that of the average experience. A *properly set* Western Red Cedar Pole will have one foot of the ground line area above and two feet below the surface of the ground (Figure A). Poles that are not set to proper depth may have the entire ground line area above the surface of the ground, where effectiveness of the treatment is lost because the actual ground line is below it (Figure B). Setting poles too deep may result in placing the entire ground line area below the surface of the ground (Figure C). This locates the ground line above the treated area where it receives little or no benefit from the preservative. A pole set in this way will react the same as though untreated.

Producers of Western Red Cedar Poles long ago recognized the importance of the ground line circumference in wood pole engineering. The small amount of processing that Western Red Cedar Poles undergo is designed to give maximum protection to the ground line area, resulting in many years service; poles set with proper regard to placing of ground line meet every requirement for maintenance of original ground line circumferences.



Pole Treating In Bell Plants

In recent years the Bell organization has concentrated effort on the purpose of producing for the utility market the highest quality Cedar Poles made available in Nature's forests, and in the butt treatment of the poles has developed and utilizes a method of incising that positively preserves all of the pole timber's original strength at the ground line—*where that strength is needed most.*

The Bell Process of Preservative Treatment is a treatment in a class distinctly its own, and is a method utilized exclusively by this company. The incising machines used are the latest development in the process of butt treatment and are the product of expert engineering skill, exhaustive research and the application of facts determined by extensive scientific study. This improved method of incising the sapwood in order to permit the free flow of creosote oil into the pole at the ground line is pronounced by engineers a very decided improvement over the older method machines that hammer in the knives or teeth. Bell's New Method Incising Machines do not break, crush or smash the wood fibers, and leave nc sliverings, abrasions or loosened sapwood—ALL of the pole's original ground line strength is preserved by SPREADING the fibers, instead of cutting or breaking them down crosswise.

Maximum Penetration to the Saturation Point

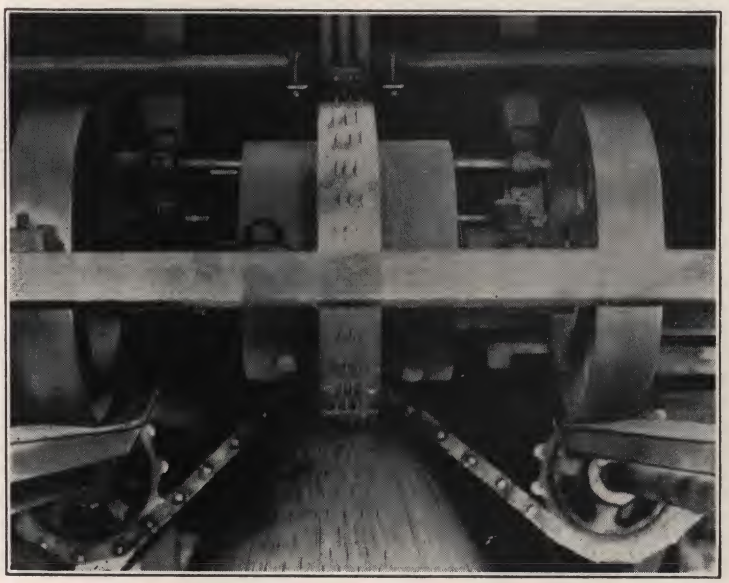
Occasionally the question is asked of our sales representatives: "How many pounds of Creosote Oil is contained in poles subjected to your process of incised treatment?" The answer can be surprisingly accurate, depending upon the individual salesman's familiarity with standard formulae utilized by the laboratories for determination. Some units in the industry guarantee definite poundage, which, however, in the face of actual tests, are specific safety minimums. The Bell Lumber & Pole Company subjects all poles treated through the incised process to immersion in the hot and cold creosote oil for a sufficient period of time to reach the saturation refusal point, and in consequence is in position to absolutely guarantee every pole treated by the Bell incising process contains *all the creosote oil it will take.* Some tests made have shown this to reach a maximum of 66.75 lbs. per cubical ft. of wood volume treated.

Comparing the actual period of time poles are subjected to immersion in Creosote Oil in Bell plants, over a period of a year's time, with requirements of specifications as provided by American Standards Association, the following result was ascertained:

	A. S. A. Specn.		*Actual Immer.*	
	Hot	*Cold*	*Hot*	*Cold*
Half-Inch (Incised) Treatment.....	8 hrs.	2 hrs.	10 hrs.	5 hrs.
"B" Treatment.....	4 hrs.	2 hrs.	6 hrs.	4 hrs.
"AA" Treatment....	¼ hr.	none	1 hr.	none

Bell's Pentrate Process Preservative Treatment

With very slight variation (depending upon the form and size of the pole being incised) Bell's incising machine makes an average of 264 incisions per square foot; determined by preliminary investigation and engineering study this is the approximate number required to secure the greatest possible volume of preservative fluid entering the wood fibers within the incised area.



The teeth utilized are set in a removable steel band on a 16″ cylinder and are rolled into the pole under pressure of the cylinder weight only. These teeth, very much resembling in shape the point of a knife blade, enter the wood fiber in such a way as to spread the fibers apart, causing a positive and full impregnation and saturation of oil in the pole, but with no injury to the wood fiber. With extra removable bands any kind of incising or spacing of the incisions can be

Above Is Shown One of the Bell Process Pentrate Plants in Operation at Our Minnesota Transfer Yard

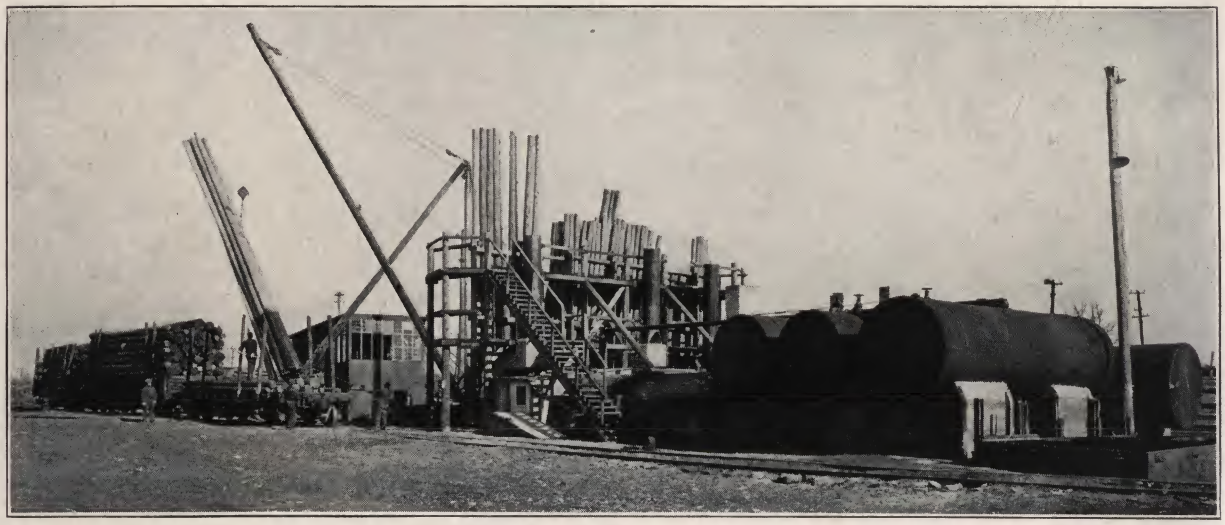
furnished as may be desired by the customer.

Each incising tooth, when completely imbedded in the sapwood, makes an incision 5/8" long and 1/8" wide, tapering from center toward both ends of the incision, and to a depth of 9/16", tapering down from the total length of the incision to a rounded point similar to the knife blade end.

The teeth in the removable steel band on the 16" cylinder are in stagger formation, the spacing being 1/2" from center to center across the pole, and 1 1/8" from center to center with grain of the wood.

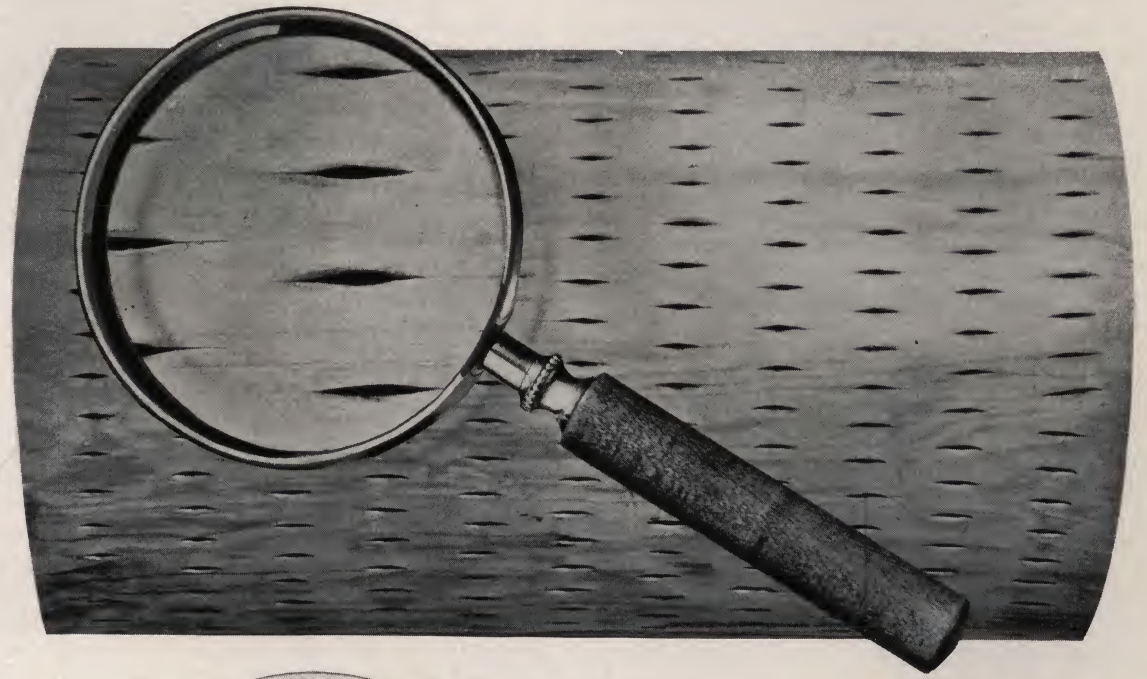
Live rolls take the pole into the machine house, centering the ground line over one of the hydraulics, then the pole is raised by the hydraulics up to the incising cylinder and held there until the work is completed. The machine turns the pole 1 1/4" at each stroke of the cylinder, the cylinder incising a strip 1 1/4" wide at each stroke, going and coming, the pole turning as the teeth raise out of the sapwood at the end of each stroke.

This View Is of One of the Two Open-Tank Treating Plants in Our Minnesota Transfer Yard



Bell's Pentrate Incising Process Preserves Pole Ground Line Strength

Below are *actual* photographs demonstrating how the knife-blade incising teeth utilized in preparing the ground line area of the pole for the Guaranteed Half-Inch or Full Sapwood treatment *spread* the wood fibres (they do not cut, crush or break), and how the incisions *almost completely close* shortly after the pole butt has been subjected to the hot-oil immersion; this process assures *sustained saturation* to the point of refusal.



Proper Storage In Utility Yards Is Important

Many utilities, in both the telephone and power field, make a practice of carrying on hand at some central point fairly good sized reserve stocks of poles in various sizes, from which stocks distribution of the poles that may be required quickly in case of emergency can be effected promptly. From an economic standpoint the proper storage and continued care of such pole stocks is important and demands careful attention to the detail of their preservation until such time as they are put into line use.

A Western Red Cedar Pole *must* be considered in the last analysis as standing in the line of its ultimate use. It is for this purpose that the pole has been produced and the storage of that pole should be with that thought clearly in mind. Improper storage may result in excessive checking, molding, sap stain, and be the direct cause of developing conditions advantageous for the formation and growth of wood-rotting fungi with subsequent deterioration and decay. Proper piling methods will not only reduce, but *will remove entirely,* such hazards to poles held in utility storage yards.

It is important in pole storage to appreciate and understand the need for the free circulation of air, through the pile, beneath and around it; and circulation is one important factor in pole storage that can be controlled. Piling poles too closely tends to delay evaporation of the moisture accumulated in the poles during rainfall or a high humidity period, often resulting in mold stain and sap decay infections. Piling poles too loosely may, on the other hand, result in too rapid drying out following such moisture conditions, and thus cause severe checking. Each locality in which is maintained pole storage facilities should be carefully studied as to the best means for controlling air circulation.

View of a Well Kept, Clean, Sanitary

As poles dry in the pile, following accumulation of moisture through rainfall or humidity, the cooling effect of evaporation of the water uses up the heat of the surrounding air. Being cooled this air is heavier than before and moves downward, or sinks, through the pile. Successive layers of cooled air gradually sink down into and through the pile, and as they move downward additional moisture is picked up and the air may become saturated, or nearly so. The pole piles should be high enough above the ground to allow this cool, moist air to pass through and be removed from under the pile. Low piles will allow the cooled air to sink half or two-thirds the way down and then stagnate partially or completely. This means that the lower tiers of poles are not

Panoramic View of a Portion of the Minnesota Transfer, Minn., Concentrating and Treating Yards of the Bell Lu
Immediate S

and Orderly Utility Storage Yard

drying properly, if at all, and may suffer sapwood deterioration before they are moved out into the line or can be repiled.

The height of piles, the space between them, the width of alleys and the direction of the prevailing winds are all important in establishing and maintaining satisfactory air circulation.

The storage yard should be provided with well constructed skids, in the construction of which a variety of materials is suitable. Many of the larger yards have skids built of concrete in the top of which is imbedded a steel rail, while others utilize wood blocking and timbers. In either case the skids should be so built as to have a space of not less than 24″ between the surface of the ground and the top of the skids. This will permit easy destruction of vegetation growing under the piles, the cleaning up of debris that might accumulate, and allow ample room for free circulation of air.

The yard, including that portion especially in and around the pole piles, should be kept free from rotting wood, stubs, blocking, or old poles that have served their useful life in the line and that have been removed because of deterioration. *All such materials should be burned or otherwise removed.*

Should the skids be constructed of timbers it is imperative that all such timbers be sound and show no signs of deterioration, and before poles are placed on them for storage the skids should be subjected to thorough brush treatment with creosote oil, which treatment should thereafter be repeated as often as the skids are emptied. This will prevent any development of wood destroying fungi where the poles come into contact with the wooden skids.

Another good practice is to change the position of the poles on the storage skids at intervals, which will not only be a means toward preventing excessive checking but will likewise prevent development of deterioration where the poles come in contact with the skids or with each other.

The individual pole cost in the line when Bell Poles are used is no greater than for other wood pole species; but, spans of greater length, heavier loads per pole, and longer life, bring the original investment down to well below the average.

mber & Pole Company, Showing Thousands of High Altitude Long Span Western Red Cedar Poles Available for Shipment

Roofing, Gaining and Boring Cedar Poles

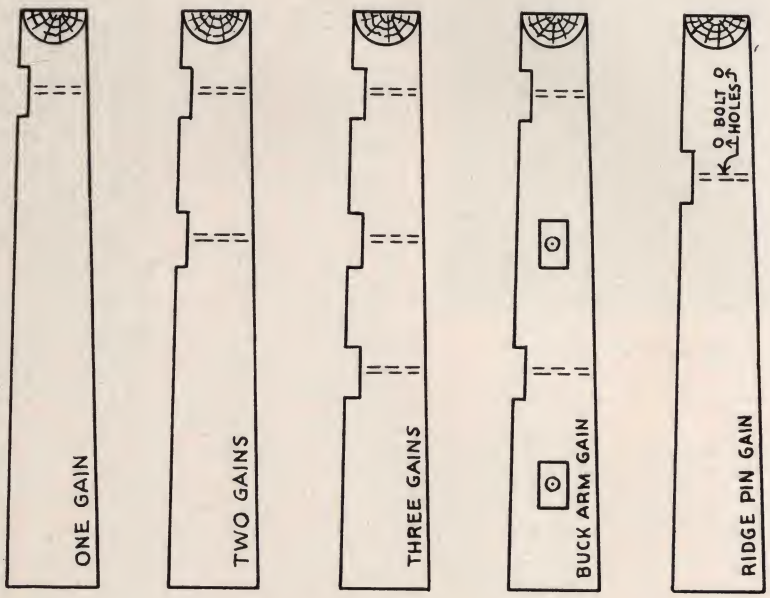
Perhaps there is no individual operation in the preparation of poles for its customers that is given more particularly careful, expert and detailed attention in Bell Lumber & Pole Company yards than is that of the Roofing of poles, the cutting in of cross arm Gains and the boring of the Bolt Holes for cross arm braces and pole steps. Such work is entrusted only to the most skilled and experienced workmen, and we always insist upon the use of the most efficient utensils and tools in order that the highest degree of accuracy prevail. This work has been brought to such a degree of perfection in our yards that many of our customers, in both the telephone and power field, insist upon such operations being done for them by our workmen.

Careful attention is given to the specail requirements of the individual utility, and we always insist upon strict compliance with the specifications provided as outlined in blueprint, drawings or special instructions.

Pole roofs, gains and bolt holes for cross arm braces are always treated, when finished, with the same No. 1 Riley Creosote Oil that is utilized in the open tank butt treatment of the poles.

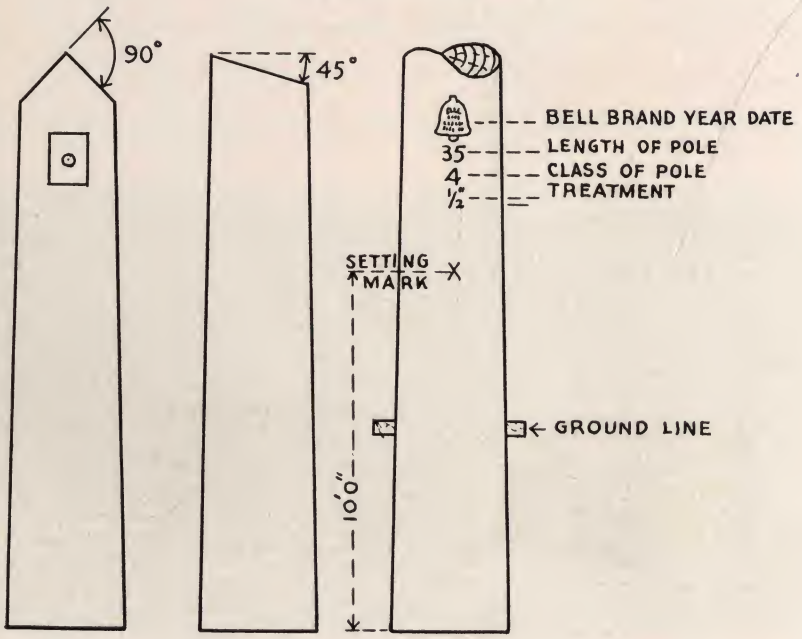
Roofing, Gaining and Boring of poles can be done much more expertly and efficiently in our yards at the time the poles are being selected for butt treatment and shipment than can be done after the poles are out on the line or set in place. And the cost of such work, done by our workmen prior to shipment of the poles, is so unusually low that many utilities find it economically advantageous to purchase their poles completely manufactured and ready for the line.

The accompanying sketch shows two types of pole roofing, a variety of gain and bolt hole cutting, and the manner in which all Bell Poles are branded to indicate year of shipment, and when desired by the customer, how the length and class or size of pole, and the type of butt treatment to which the pole has been subjected, are indicated.



Gaining and Bolt Hole Boring

Number of Gains and Bolt Holes and Spacing Between Gains and Bolt Holes as Per Specifications of Customer.



A Good Stain When Required On Poles In City Use

The use of paint of any kind for coloring poles when such coloring is required under city ordinances is not recommended. Research has shown that such painting of poles is an important contributing factor to the setting up of conditions causing much earlier deterioration of the sapwood than would otherwise prevail. The paint forms a more or less solid film over the surface of the pole and this acts directly to retard rapid evaporation of moisture absorbed by the pole through checks, or other small opening, such as those caused by linemen's spurs.

Cedar sapwood absorbs moisture very readily, but has the quality of permitting rapid evaporation of this moisture where such process is not impeded by paint or other film covering. Any coloring material utilized that will form a solid coating or film naturally causes a retention of the moisture in the wood and creates conditions very favorable to the growth of wood destroying fungi.

A good stain to use, one which does not "seal" the pole surface, but which allows free moisture evaporation from the sapwood, is a ground in oil paste and uncolored creosote oil, mixing proportions approximating one pound of paste to one gallon of oil, preferably mixing in small quantities and putting on with a spray gun. Any color desired can be prepared. Stain mixed with these ingredients not only gives the desired color effect but acts as an additional sapwood preservative, as well, the uncolored creosote oil containing sufficient toxic qualities for wood preservation.

The Bell Lumber & Pole Company makes a specialty of staining poles as may be required by its customers for use in complying with city ordinances and is prepared, through the use of modern utensils operated by skilled workmen, to do such work on short notice, at only moderate charges per pole.

Cedar Heartwood Termite Resistant

In a brief summary of his report covering investigation of termite damage to cedar poles, Dr. J. P. Wentling, Director of Research in the cedar pole industry, says: "Termites are insects that use wood for food. They are commonly called 'white ants.' They are, however, not true ants and some of them are jet black instead of white. Ants and termites are so different that effective ant-control measures may be worthless when applied to termites.

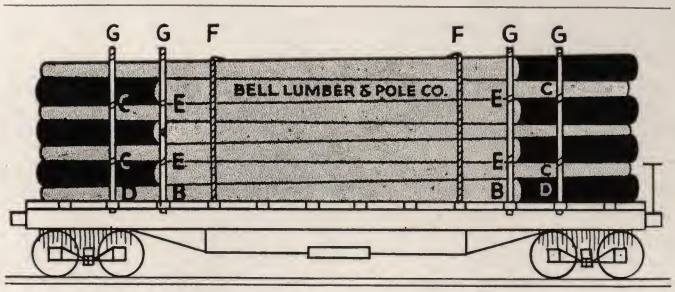
"Not any of our pole woods are naturally termite proof, but laboratory experiments indicate that the heartwood of the Western Red Cedar may be classed as naturally termite resistant.

"The dry-wood termite is found only along the extreme southern rim of the United States from California to North Carolina. The subterranean or 'underground' termite is widely distributed and is responsible for most of the termite problems of this country. Poles butt treated with creosote by the incised method are amply protected against this underground termite, and this process is so recommended by the Termite Investigations Committee of California and by the U. S. Bureau of Entomology."

Rules for Unloading Cedar Poles

In order to avoid injury to employees and the unnecessary damage or breaking of poles during the unloading of cars in the storage yard there are certain definite instructions it should be insisted that unloading crews observe carefully.

Never allow anyone on top of a load of poles under any circumstances. Never cut the top wires (G in the sketch). Always unload the car in the same direction in which it is leaning. If yard conditions necessitate violation of this rule be sure to place substantial props against the load on the opposite side. For absolute safety attach cables (or heavy ropes) to the car pockets, throwing these over the car as per (F) in the sketch. The cables (or ropes) are then securely fastened to pockets on the opposite side of the load in a manner making it possible for the cables (or ropes) to be gradually released by snubbing. Then carefully, and in exact rotation, cut the two inside stakes at (B), cut the wires at (E), cut the outside stakes at (D) so that they are free at the pockets, but both wires (C) are still intact. Cut the center wire (C), using an extraordinary long-handled axe or other wire cutting tool, so that a man standing at the end of the car is out of danger. The stakes, having been previously cut, will swing out from the load but the cables (or ropes) (F) will still hold the poles in position and make it impossible for the load to fall. Release the snubs gradually until the poles reach the skids.



MAP OF UNITED STATES
SHOWING NORTHERN LIMITS OF DAMAGE TO WOOD
BY TWO TYPES OF TERMITES

1. Northern limits of damage by above ground termites.
2. Northern limits of damage by below ground termites.

Line No. 1 shows the northern margin of damage to wood by the "flying," "swarming," "above ground" or "non-subterranean" termites. This area also has the "below ground" or "subterranean" termite. Both types are present here and will work in wood both below and above ground.

Line No. 2 shows the northern limits of reported damage to wood in some form by the "underground" or "subterranean" type.

Creosote gives protection against work of all termites. **Incised butt treating** gives adequate protection against the "underground" type and is the kind of treatment recommended.

Termites are not necessarily evenly distributed throughout the entire area lying south of these lines 1 and 2. Their distribution may be very "spotted."

Above map verified by United States Bureau of Entomology.

Northern White Cedar For Pole Line Use

UNDOUBTEDLY there are many reasons that can be stated in explanation of the continuing popularity of Northern White Cedar Poles for use in pole line construction, more particularly in the lines of telephone and telegraph organizations rather than in the transmission and distribution systems of power utilities, but perhaps the most outstanding are because of its—

More than half-century record of service.
Natural resistance to decay.
Secure anchorage, through its large circumference of butt in proportion to its length.
Light weight, and subsequent low cost of installation.
Abundant availability of short length sizes.

While native to forests of Ontario, Canada, the Northeastern states, and the lake states of Michigan, Wisconsin and Minnesota, in recent years the larger proportion of Northern White Cedar Poles going into the utility market have been from production operations within those timber areas of the three states named bordering on the Great Lakes, where Nature has made available an abundant year-after-year supply of the short length sizes which have, through experience, been found so peculiarly and particularly adapted to telephone and telegraph line construction.

Because of its very natural slow growth Northern White Cedar does not grow to great height and the bulk of production is confined to lengths, for pole line use, ranging from 16′ up to and including 35′, and this fact, alone, since the advent of the heavy transmission power line requiring longer poles and greater clearances, has practically eliminated it from consideration for power line uses, and thus confines its usability to plants of telephone and telegraph organizations.

An Extraordinary Record of Service

Due to the fact that Northern White Cedar Poles have gone into pole line construction many years prior to the use of other timber species, with the possible exception of Chestnut, they have established a service record not yet equalled by other wood poles. Recent investigations of White Cedar Pole lines built as long ago as twenty and twenty-five years, in which lines thousands of untreated poles were placed, finds a rather startling proportion of the original poles put into use are still in the line, successfully withstanding onslaught of wind, sleet and ice, and attack by wood-rotting fungi, while open-tank creosote butt treated Northern White Cedar Poles placed in the lines of the American Telegraph and Telephone Company back in 1909, and subjected later to periodical inspections, have established a record of service that alone is sufficient proof as to the safety and economy in construction use of this species of wood pole.

One of the Bell Lumber & Pole Company's Production and Woods Point Shipping Yards

Secure Anchorage and Natural Decay Resistance

Northern White Cedar Poles have a rather sharp and accentuated taper, averaging about 1″ to every 5′ of length. This taper results in large circumference butts in proportion to pole length, assuring anchorage security in the line impossible to obtain with poles without similar characteristics, and is an important factor for consideration in the construction of short-pole lines carrying a large number of conductors, especially in heavy loading areas, where it will be found that Northern White Cedar Poles, under stress of the most severe wind, sleet and ice storms, will "carry the load" while lines of other wood pole species with similar loads, will pull out and go down, with consequent service interruption and added costs of new installation.

The wood of the Northern White Cedar is light in weight, fine grained, fine textured, the heartwood being a light brown to pale brown color, with the sapwood broad and nearly white. The heartwood particularly is naturally extremely resistant to decay, and when this natural quality is augmented by creosote treatment of the sapwood in the ground line area, there becomes available a pole capable of meeting the requirements, as to servicability and durability, of the most exacting engineers in the telephone and telegraph field.

Strength Comparable With Competitive Species

Under the specifications adopted by the American Standards Association covering wood poles of the various timber species, it is demonstrated that the strength of Northern White Cedar is comparable, class for class size, to the breaking strength allotted to poles from the other timber species.

The six-foot from butt circumferences have been so calculated, on the basis of the respective fiber strengths of 7,400 for Pine, 6,000 for Chestnut, 5,600 for Western Red Cedar and 3,600 for Northern White Cedar, that every pole, from shortest to longest, within a given class, has breaking strength not less than that set for its class. In the calculations it is assumed that the load is applied at two feet from the top of the pole and that the break will occur at the ground line. It will be noted that the strength increment between classes approximates 25 percent. The breaking loads set for Classes 1 to 7, applicable to the four species of wood poles designated, are as follows:

Untreated Northern White Cedar Poles in the Wildwood to Stillwater Lines of the Twin City Rapid Transit Co., After 34 Years of Continuous Use

Class	Breaking Loads
7	1,200#
6	1,500#
5	1,900#
4	2,400#
3	3,000#
2	3,700#
1	4,500#

Since no butt dimensions are specified for the poles of Classes 8, 9 and 10, the breaking strengths of these poles can be determined accurately only by actual measurement of the ground line circumferences of the individual poles. On the basis, however, of the average taper factors applied to the minimum tops, the breaking loads for Classes 8, 9 and 10, 25′ poles, may be estimated as follows:

Sizes of Poles

Class	Top Circf.
10	12″
9	15″
8	18″

Breaking Loads in Pounds

Pine	Chestnut	Western Cedar	Northern Cedar
540	700	620	830
870	1,070	940	1,110
1,320	1,540	1,380	1,530

These breaking loads would be greater for poles having greater taper and smaller for poles having less taper, and the loads would vary also for pole lengths other than twenty-five feet.

Comparative Resisting Moments of Fiber Stress

In order to compare strength factors applicable to the three most widely used species of wood poles, and to show these factors in relation to each other, the following table has been compiled showing the computed ground line diameter, ground line circumference and computed "resisting moments of fiber stress," in accord with tabulations appearing in publications of the Bureau of Standards. In deducing the diameters allowance has been made for the recognized taper of 1″ in 5′ for Northern White Cedar, 1″ in 7′ for Western Red Cedar, and 1″ in 10′ for Southern Pine, conforming to the requirements of specifications applicable to each specie, and based upon the assigned strength values for each species as established under American Standards Association specifications. In this table the computed diameters and circumferences are at the ground line, in inches. In disposing of fractions in these dimensions, less than .25″ has been disregarded, .25″ to .74″ has been called ½″, and .75″ and over has been designated full inches.

	Northern White Cedar			Western Red Cedar			Southern Pine		
Size	Dia.	Circ.	Resistance	Dia.	Circ.	Resistance	Dia.	Circ.	Resistance
4″ 20′	7.2	22.5	10817	6.3	20	11818	5.6	17.5	10462
5″	8.2	26	16692	7.3	23	17974	6.6	20.5	16850
6″	9.2	29	23162	8.3	26	25965	7.6	24	27000
7″	10.2	32	31119	9.3	29	36029	8.6	27	38400
5″ 25′	8.8	27.5	19750	7.7	24	20422	6.9	21.5	19450
6″	9.8	31	28292	8.7	27.5	30723	7.9	25	30500
7″	10.8	34	37326	9.7	30.5	41914	8.9	28	42850
8″	11.8	37	48104	10.7	33.5	55539	9.9	31	58150
6″ 30′	10.8	34	37326	9.4	29.5	37925	8.4	26.5	36350
7″	11.8	37	48104	10.4	32.5	50750	9.4	29.5	50150
8″	12.8	40	60780	11.4	36	68924	10.4	32.5	67050
6″ 35′	11.8	37	48104	10.1	31.5	46200	8.9	28	42850
7″	12.8	40	60780	11.1	35	63338	9.9	31	58150

Engineering Advice Available to Pole Users

One of the most important factors bearing upon the satisfactory use of poles is the selection of the proper pole to use on each job. In making selections, proper consideration should be given to various stresses to which the poles will be subjected, as well as to conditions which may affect the useful span of life in service.

Most of the instances of pole failures which have come to our notice have been directly traceable to the selection of poles not suited to the conditions under which they were used.

It has always been the policy of the Bell Lumber & Pole Company to render the most comprehensive service possible to its customers—not to merely sell poles. Now another link has been added to the chain of Bell Service.

We have added to our already comprehensive staff an Engineering Department, the purpose of which will be to assist, in every way possible, those whose responsibilities include the design of lines of any character. Matters referred to this department will always be handled by men who are not merely versed in the theory of line design and construction, but who have devoted many years of their lives to this work. The services of this department may be utilized in such form, or to such extent, as may best suit the individual needs of each case. Plans and estimates already prepared—or under consideration—will be checked, and recommendations submitted, or complete plans and estimates, embodying recommendations covering materials best suited to the project under consideration, will be prepared and submitted.

It is a fact clearly recognized by all who are familiar with the facts, that most men who have the responsibility of the operation of small and moderate size properties hesitate to include in the personnel of their organizations men who can handle such work for them—and fewer still can spare the time to handle such work in the way they really want it handled.

If you find yourself in that position, please feel free to call upon us. We want to help you, and the whole matter will be entirely confidential. Simply send us a general outline of what you contemplate doing, and tell us just what assistance you wish us to render you—whether to merely check your plans and estimates and make recommendations, or to submit complete plans, estimates, etc., for you to choose from.

In outlining work which you wish our Engineering Department to design for you, please be sure to give as accurate a description as possible of the general geographic layout, and, also, whether you want designs to cover lines which (1) will provide the utmost in service security, (2) provide the greatest possible service security at a given cost, or (3) provide reasonably satisfactory service at the least possible initial cost.

Bell Poles give longer service, carry heavier loads and permit longer than average spans—service experience has proved this many times. They are just the kind of poles that will, from an economy in construction and a service durability standpoint, bring you the same degree of satisfaction hundreds of other users of Bell Poles now enjoy. Bell Poles are better because Nature makes them that way.

Useful Engineering Data

In the tables given in this section the purpose is to present such data as should be of frequent assistance to the operating, or construction, man.

It is not anticipated that the data given here will suffice to design a complete Transmission, or Distribution, system. Such problems require a careful, analytical study of all the various factors which always govern decisions, and a much more satisfactory solution can be readily obtained by the busy operating man by submitting the whole problem to our Engineering Department.

In submitting such problems it is always advisable to make a rough sketch of the proposed lay-out, showing all important distances, location of prospective customers, and the approximate anticipated load of each. Such a sketch should be accompanied by a full description of the project, giving all possible information as to topography of the land, trees along the highway, or right-of-way, existence of telephone or power lines adjacent to the proposed line, as well as the existence of any other form of interference. Points at which the proposed line will cross railways, other telephone, telegraph or power lines, should be shown, as well as the height required to clear these lines. It should also be stated what the laws of the State require as to clearance of the lowest wire of a line above ground, if it is a power line construction that is to be considered.

The economics of line construction are a very important factor in determining the advisability of any construction project, and these matters should be given full consideration. It is, therefor, wise to give quite complete data as to generating conditions, including the approximate cost of current on the station bus, of the cost, per KWH if current is purchased. If the anticipated load is of such character as to make continuity of service the prime consideration, this fact should be stated. Going to the opposite extreme, it is necessary that we know the facts in case it is essential to provide the facilities for service with least possible investment of capital. Perhaps the choice lies somewhere between these two conditions. If so, the requirements can also be met.

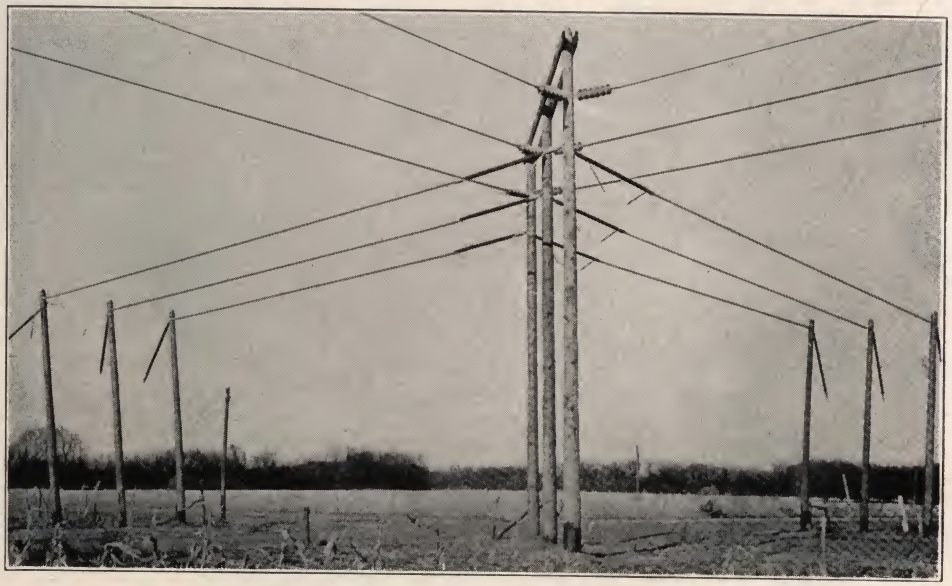
Just tell this Department your problem—whatever the conditions may be—and we will help you solve it. Our relations with each individual, in all cases, are strictly confidential.

Selection of the Proper Poles

Poles are probably the subject of more discussion than any other single item entering into the construction of utility properties. The questions of the useful life, the appearance, the strength—in short, the general economic suitability of this species, or that, of pole timber, seems always to be a controversial topic among construction, and operating, men. We have even heard the statement that Cedar Poles obtainable today are not up to the quality standards of former years. This, the Engineering Department KNOWS is not the case. As stated in another section of this publication, constant research, and development of new methods in all branches and steps of the preparation of today's Western Red Cedar Poles result in the delivery to the user of the best that has ever been offered in Cedar Poles, assuming they are purchased from reputable pole producers and suppliers.

Comparisons are frequently made where there is no real basis of comparison. More often than not, in such cases, the Cedar Poles in question had seen more years of service than was credited to them. And, in a great many instances, their se-

Bell High Altitude Long Span Poles Used in One Type of Corner Construction



lection, in the first place, was not based upon proper consideration of the duty to be imposed upon them. In other words, a more or less "rule of thumb choice" was made as to size and strength.

In other sections of this publication will be found tables giving the dimensions and strength data for the various sizes and classes of Cedar Poles. The tables that follow give complete characteristics of line conductor materials, and also tables of the loads, per foot, per wire, of each size of these conductors under any conditions likely to be encountered in service. Under the heading "Load Per Lineal Foot Vertical" will be found three columns of figures. The first column gives the dead weight, per foot, per wire, of each size conductor. The second column gives the weight of this same conductor, with a ½" coating of ice. In the third column is the weight of the same conductor, with a ¾" coating of ice.

Under the heading "Load Per Lineal Foot Horizontal" are three columns of figures. These figures all represent only the horizontal pressure against the line that is exerted by a wind blowing at right angle to the line. This is the stress that tends to tip the line to one side. In the first column are given the pressures that will be exerted against each wire, per foot, by a wind blowing approximately 75 miles per hour. In the second column are shown the pressures that will be exerted against each wire, per foot, by wind blowing at approximately 55 miles per hour, against each size wire, when it is coated with ½" of ice. In the third column is the pressure, per wire, per foot, exerted against the line by a wind blowing 65 miles per hour against the line when coated with ¾" of ice.

The columns of figures under the heading "Maximum Load Per Lineal Foot in Plane of Resultant" give the combined effect of the "punishment" that will be inflicted, per foot, per wire, on the line by the combination of the conditions covered in the two preceding headings. The figures under this last named heading are the figures that should be used in deciding on the size, or class, of poles to be used.

The notes at the foot of the tables give the load that is contemplated by each class of loading. Select the conditions under which you want your lines to stand up (Class A, Class B or Class C). Multiply the figure, under this class, for each size wire. Add the products obtained for each size and multiply this sum by the factor of safety you desire to employ. The product will be the "load" to carry which a pole of definite strength is required.

Having now determined the "load," multiply this by the lever arm (which will be dependent upon the length of pole desired to secure the clearances required, the lever arm being that portion of the pole extending from a point 2′ below the top down to the actual ground line) and ascertaining the required "moment of resistance" turn to the table on Page 33 entitled "Ultimate Resisting Moments for Fiber Stress" and find the required pole ground line circumference opposite the moment of resistance corresponding to your figures. Then turning to the dimension and circumference tables shown under the various specifications and selection can be made, as to size, of the pole with ground line circumference corresponding to that which it has been determined is required for the "load."

A Word About Loading Classifications

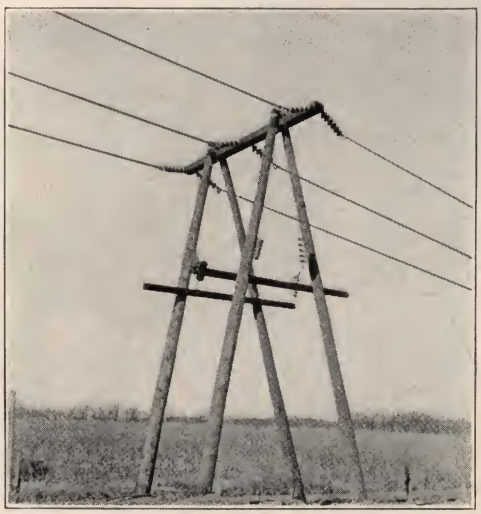
The three classes of loading shown under "Maximum Load Per Lineal Foot in Plane of Resultant" are calculated to represent conditions encountered in different sections of the United States.

Class A Loading anticipates conditions met with in Southern Sections, where ice and sleet are seldom encountered.

Class B Loading anticipates conditions met within the Central and Northern Sections where a moderate coating of ice, or sleet, is not uncommon, but where the coating is soft enough to be broken off the wire by a stiff wind.

Class C Loading anticipates conditions met with in the Western and Mountainous Sections, where a combination of extreme cold and high winds frequently prevail.

One Type of Storm Structure in the Plains States Carrying 66,000 kva, Built With Bell Long Span Poles



Wind Pressures

Approximate Pressure in Pounds Per Square Foot at Various Velocities

Velocity Miles Per Hour	Pressure Lbs. Per Sq. Ft.
20	1.00
25	1.55
30	2.10
35	3.00
40	3.80
45	4.90
50	6.00
55	7.50
60	9.00
65	10.50
70	12.00
75	14.00
80	16.00

Line Loading Tables

Size C.M. or A.W.G.	Max. Amps. Bare*	Max. Amps. W.P. Ins.*	Resistance Ohms Per Mile	Diameter Inches	Area Sq. In.	Hard Drawn Ultimate Tension, Lbs.	Hard Drawn Allowable Tension, Lbs.	Soft Drawn Ultimate Tension, Lbs.	Soft Drawn Allowable Tension, Lbs.	Ld., per lin. ft., Ver. Dead	Ld., per lin. ft., Ver. Dead Plus ½ In. Ice	Ld., per lin. ft., Ver. Dead Plus ¾ In. Ice	Ld., per lin. ft., Hor. 15 Lbs. Per Sq. Ft.	Ld., per lin. ft., Hor. 8 Lbs. Per Sq. Ft. + ½" Ice	Ld., per lin. ft., Hor. 11 Lbs. Per Sq. Ft. + ¾" Ice	Max. ld., per lin. ft. In plane of resultant Class A Loading	Max. ld., per lin. ft. In plane of resultant Class B Loading	Max. ld., per lin. ft. In plane of resultant Class C Loading
Copper Conductor Stranded																		
500000	1010	600	0.1127	0.819	0.3924	23540	11750	13340	6650	1.525	2.345	2.989	1.024	1.213	2.126	1.837	2.640	3.668
350000	735	450	0.1611	0.679	0.2750	16500	8250	9350	4650	1.068	1.801	2.401	0.849	1.119	1.997	1.364	2.120	3.123
0000	550	325	0.2667	0.530	0.1662	9970	5000	5650	2800	0.645	1.286	1.831	0.663	1.020	1.861	0.925	1.641	2.611
000	460	275	0.3360	0.470	0.1318	7910	3950	4480	2250	0.513	1.116	1.651	0.588	0.980	1.806	0.780	1.485	2.446
00	400	225	0.4229	0.420	0.1045	6270	3150	3555	1750	0.406	0.978	1.498	0.525	0.947	1.760	0.664	1.361	2.311
0	344	200	0.5342	0.375	0.0829	4970	2500	2820	1400	0.322	0.866	1.372	0.469	0.917	1.719	0.569	1.261	2.199
1	275	150	0.6720	0.330	0.0657	3940	1950	2235	1100	0.255	0.771	1.263	0.413	0.887	1.678	0.485	1.175	2.100
2	252	125	0.8486	0.291	0.0521	3130	1550	1770	900	0.203	0.695	1.174	0.364	0.861	1.642	0.417	1.107	2.019
3	206	100	1.0710	0.261	0.0413	2480	1250	1405	700	0.160	0.633	1.103	0.326	0.841	1.614	0.363	1.053	1.955
Copper Conductor Solid																		
0000	550	325	0.2667	0.460	0.1662	8310	4150	5650	2800	0.641	1.238	1.770	0.575	0.973	1.797	0.816	1.575	2.522
000	460	275	0.3360	0.410	0.1318	6590	3300	4480	2250	0.509	1.074	1.591	0.512	0.940	1.750	0.722	1.427	2.365
00	400	225	0.4229	0.365	0.1045	5220	2600	3555	1750	0.403	0.940	1.443	0.456	0.910	1.709	0.608	1.309	2.237
0	344	200	0.5342	0.325	0.0829	4560	2300	2820	1400	0.320	0.833	1.323	0.406	0.883	1.673	0.517	1.214	2.133
1	275	150	0.6720	0.289	0.0657	3740	1850	2235	1100	0.253	0.744	1.223	0.362	0.860	1.640	0.442	1.137	2.046
2	252	125	0.8486	0.258	0.0521	3120	1550	1770	900	0.202	0.698	1.142	0.322	0.838	1.611	0.380	1.075	1.975
3	206	100	1.0710	0.229	0.0413	2480	1250	1405	700	0.159	0.613	1.073	0.287	0.820	1.585	0.328	1.024	1.914
4	183	90	1.3500	0.204	0.0328	1960	1000	1115	550	0.126	0.564	1.016	0.255	0.803	1.567	0.284	0.981	1.863
5	168	80	1.7030	0.182	0.0260	1560	800	885	450	0.100	0.524	0.969	0.227	0.788	1.542	0.248	0.946	1.821
6	142	70	2.1470	0.162	0.0206	1240	600	700	350	0.079	0.491	0.930	0.203	0.775	1.524	0.218	0.917	1.785
Aluminum Conductor Stranded Steel Re-inforced																		
500000	810	400	0.1832	0.814	0.3924	23956	17000	...	...	0.777	1.597	2.236	1.335	1.526	2.438	1.434	2.079	3.177
330400	550	325	0.2719	0.679	0.2750	16200	11000	...	...	0.528	1.361	1.861	1.055	1.325	1.203	1.114	1.744	2.800
0000	400	225	0.4308	0.522	0.1662	8435	5900	...	...	0.295	1.931	1.482	0.752	1.115	1.953	0.781	1.412	2.412
000	344	200	0.5417	0.464	0.1318	6660	4650	...	...	0.232	0.832	1.365	0.657	1.053	1.877	0.677	1.311	2.290
00	275	150	0.6832	0.414	0.1045	5300	3700	...	...	0.185	0.754	1.271	0.581	1.006	1.817	0.595	1.231	2.193
0	252	125	0.8654	0.368	0.0879	4200	2900	...	...	0.147	0.687	1.190	0.510	0.962	1.762	0.520	1.162	2.107
1	206	100	1.0930	0.328	0.0657	3340	2300	...	...	0.117	0.632	1.122	0.450	0.925	1.716	0.457	1.105	2.035
2	183	90	1.3781	0.291	0.0521	2660	1800	...	...	0.093	0.565	1.064	0.396	0.893	1.674	0.400	1.055	1.971
3	168	80	1.7377	0.261	0.0413	2100	1400	...	...	0.074	0.547	1.017	0.351	0.866	1.639	0.354	1.015	1.919
4	142	70	2.1912	0.231	0.0328	1665	1100	...	...	0.058	0.513	0.973	0.308	0.840	1.606	0.311	0.977	1.865

*These values do not take into consideration drop in voltage.

Current, In Amperes, Per Phase, in Three Phase Circuits

At Commonly Used Voltages (Power Factor 80%)

Volts	100KW	200KW	300KW	400KW	500KW	600KW	700KW	800KW	900KW	1000KW
2200	32.80	65.60	98.40	131.00	164.00	197.00	230.00	262.00	295.00	328.00
6600	10.90	21.90	32.80	43.70	54.70	65.60	76.50	87.50	98.40	109.00
11000	6.56	13.10	19.70	26.20	32.80	39.40	45.90	52.50	59.00	65.60
13200	5.47	10.90	16.40	21.90	27.30	32.80	38.30	43.70	49.20	54.70
22000	3.28	6.56	9.84	13.10	16.40	19.70	23.00	26.20	29.50	32.80
33000	2.19	4.37	6.56	8.75	10.90	13.10	15.30	17.50	19.70	21.90
66000	1.09	2.19	3.28	4.37	5.47	6.56	7.65	8.75	9.84	10.90

Comparision of Conductor Materials On Basis of Equal Conductivity

Material	Diameter	Weight	Strength
Copper	1.00	1.00	1.00
Aluminum	1.27	0.485	1.26
Iron	2.72	6.36	5.30
Copper-Clad Steel	1.52	2.12	4.46

Ultimate Resisting Moments for Fiber Stress

Formula $M = .0002638\ fC^3$ = Moments in Pound-Feet; where, the f — Fiber Stress (Modulus of Rupture) in Pounds per Square Inch, and C — Circumference of the Pole at Ground Line in Inches (6′ from Butt). See National Electrical Safety Code, 3rd Edition, Page 225. This formula is the same as that used for figuring beams of symmetrical shapes and, therefore, does not take into consideration the factor of taper in the pole or moment of inertia.

Ground Line Circumference	White Cedar	Western Red Cedar	Ground Line Circumference	White Cedar	Western Red Cedar	Ground Line Circumference	White Cedar	Western Red Cedar
18″	5539	8615	31.5″	29705	46209	45″	86540	134617
18.5	6013	9354	32	31119	48408	45.5	89489	139205
19	6514	10133	32.5	32624	50748	46	92438	143793
19.5	7042	10954	33	34129	53089	46.5	95485	148533
20	7597	11818	33.5	35704	55539	47	98599	153376
20.5	8182	12727	34	37326	58063	47.5	101813	158375
21	8795	13681	34.5	39022	60700	48	105027	163375
21.5	9438	14682	35	40718	58063	48.5	108378	168588
22	10112	15730	35.5	42513	66131	49	111729	173801
22.5	10817	16827	36	44308	68924	49.5	115184	179175
23	11555	17974	36.5	46206	71876	50	118710	184660
23.5	12325	19172	37	48104	74829	50.5	122343	190311
24	13128	20422	37.5	50107	77945	51	125976	195963
24.5	13966	21725	38	52111	81061	51.5	129754	201840
25	14838	23083	38.5	54195	84303	52	133533	207717
25.5	15747	24495	39	56334	87631	52.5	137422	213767
26	16692	25965	39.5	58557	91088	53	141386	219933
26.5	17673	27492	40	60780	94546	53.5	145463	226275
27	18693	29077	40.5	63116	98181	54	149540	232618
27.5	19750	30723	41	65453	101816	54.5	153771	239200
28	20849	32389	41.5	67878	105586	55	158003	245782
28.5	21984	34198	42	70360	109449	55.5	162391	252608
29	23162	36029	42.5	72903	113404	56	166779	259434
29.5	24381	37925	43	75506	117454	56.5	171326	266508
30	25641	39887	43.5	78202	121647	57	175874	273582
30.5	26945	41914	44	80898	125841	58	185294	288235
31	28292	44010	44.5	83687	130180	59	195044	303402

Specifications for Western Red Cedar Poles

W. R. C. A. Grade

Standard or "Woods Run" Poles, 4"-20' and Larger

1—*Live Timber:* All poles must be manufactured from live growing cedar timber.

2—*Manufacture:* All poles must be peeled, knots trimmed close and butts and tops sawed square.

3—*Variation In Length:* Poles may be 6 inches longer or 3 inches shorter than length specified.

4—*Knots:* Knots are not a defect, if sound, trimmed smoothly, and do not plainly impair the strength of the pole.

5—*Discoloration:* Discoloration is not a defect.

6—*Miscellaneous Defects:* No poles shall contain sap rot, woodpecker holes, plugged holes or evidence of having been eaten by ants.

7—*Rot:* Top of poles must be free from rot. Butt rot in center, including small ring rot, shall not exceed 10 percent of the area of the butt. Butt rot of a character which impairs the strength of the pole above the ground line is a defect.

8—*Cat Faces:* Sound cat faces are not a defect if no part of the cat face shows on the upper one-fifth of the length of the pole or within 2 feet above or 1 foot below the ground line.

9—*Dead or Dry Streaks:* A sound dead or dry streak is not a defect if it does not cover more than 25 percent of the surface of the pole at any one point.

10—*Minimum Measurements:* (a) The tops of all poles shall have a minimum circumference measurement as shown in the "Table of Measurements, W.R.C. A. Grade." (b) The extreme butt of all poles shall have a minimum measurement as shown in the "Table of Measurements, W.R.C.A. Grade." (c) Poles having a decided swell or flare at the butt shall have a sufficiently larger measurement at the butt to insure a reasonable measurement at the ground line.

11—*Short Kinks:* Short kinks are not permitted.

12—*Reverse Sweep:* Reverse sweep and two-way sweep, meaning a sweep in two planes, is permitted, provided that a straight line drawn from the center of pole at the top to center of pole at the ground line does not leave the pole at any point.

13—*One-Way Sweep:* One-way sweep is permitted provided it does not exceed the maximum shown in the "Table of Measurements, W.R.C.A. Grade."

14—*Method of Measuring Sweep:* That part of the pole below the ground line is not to be taken into consideration. Tightly stretch a tapeline from point at the ground line (see paragraph 15) on the side of the pole where sweep is greatest to the upper surface at the top of the pole, and having so done, measure widest point from tape to surface of pole and if, for illustration, upon a 30' pole the widest point does not exceed 4", this pole shall be accepted. (See illustrations on Page 40.)

15—*Explanation of Term "Ground Line":* The term "ground line" as used in these specifications shall mean a point on the pole a distance of 4' on 20 foot, 5' on 25 foot and 30 foot, and 6' on 35 foot and longer poles, from the extreme butt.

N. E. L. A. (or A. T. & T.) Grade

1—*General:* The material desired under these specifications consists of poles and guy stubs of the best quality of either seasoned or live green cedar of the dimensions specified in the "Table of Measurements, N.E.L.A. Grade." The poles covered by these specifications are of Western White Cedar, otherwise known as red cedar, western cedar or Idaho cedar. Seasoned poles shall have preference over green poles provided they have not been held for seasoning long enough to have developed any of the timber defects hereinafter referred to. All poles shall be reasonably straight, well proportioned from butt to top, shall have both ends squared, sound tops, the bark peeled, and all knots and limbs closely trimmed.

2—*Dimensions:* The dimensions of the poles shall be in accordance with the measurement shown in the "Table of Measurements, N.E.L.A. Grade," the "top" measurement being the circumference at the top of the poles, and "butt" measurement the circumference six (6) feet from the extreme butt end. The dimensions given are the minimum allowable circumferences at the point specified for measurement and are not intended to preclude the accep-

Table of Measurements, W. R. C. A. Grade

Size	Lbs. Wgt.	Min. Top Circum. (Inches)	Min. Ex. Butt Circum. (Inches)	Ground Line* (Feet)	Maximum Sweep Between Top and Ground Line (Inches)	No. Poles Per Car Min.	Max.
4" 20'	100	12		4	3	500	750
5" 20'	135	15		4	3	370	500
6" 20'	190	18½		4	3	250	400
7" 20'	250	22		4	3	200	300
8" 20'	325	25		4	3	155	230
5" 25'	200	15		5	3	250	375
6" 25'	250	18½		5	3	200	300
7" 25'	325	22		5	3	155	230
8" 25'	400	25		5	3	125	175
6" 30'	325	18½		5	4	150	200
7" 30'	400	22		5	4	125	190
8" 30'	550	25		5	4	90	125
6" 35'	450	18½		6	5	110	180
7" 35'	550	22	33	6	5	90	125
8" 35'	650	25	36	6	5	75	115
7" 40'	675	22	34	6	5½	90	115
8" 40'	800	25	37	6	5½	70	90
8" 45'	1000	25	39	6	6	65	85
9" 45'	1200	28	42	6	6	70	85
8" 50'	1200	25	41	6	7	70	85
9" 50'	1400	28	44	6	7	60	90
8" 55'	1400	25	42	6	8	60	90
9" 55'	1600	28	45	6	8	50	75
8" 60'	1600	25	44	6	9	50	75
9" 60'	1850	28	47	6	9	45	65
8" 65'	1850	25	45	6	10	45	65
9" 65'	2200	28	48	6	10	40	55
8" 70'	2200	25	47	6	10½	40	55
9" 70'	2600	28	50	6	10½	30	50
8" 75'	2600	25	48	6	11	30	50
9" 75'	3000	28	51	6	11	30	50
8" 80'	3000	25	50	6	12	25	40
9" 80'	3500	28	53	6	12	20	35
8" 85'	3500	25	51	6	13	20	35

*Feet from butt (for measuring sweep only).

Minimum Weight Required for Carloads

Single Car—Shorter than 40'.....40,000 lbs.
Single Car—40', 45' and 50'.....50,000 lbs.
Double Loads—45' and Longer, or 45' and Shorter.....66,000 Lbs.
Triple Loads.....99,000 lbs.
(20% over minimum required should be added to cover variations in weights.)

tance of poles of larger dimensions. When the dimension at the butt is not given the poles shall be reasonably well proportioned throughout their entire length. No pole shall be over six (6) inches longer or three (3) inches shorter than the length for which it is accepted. If any pole is more than six (6) inches longer than is required, it shall be cut back.

3—*Quality of Timber:* (Poles) No dead poles and no poles having dead streaks covering more than one-quarter of their surface shall be accepted under these specifications. Poles having dead streaks covering less than one-quarter of their surface shall have a circumference greater than otherwise required. The increase in the circumference shall be sufficient to afford a cross sectional area of sound wood equivalent to that of sound poles of the same class.

4—*Twisted, Checked or Cracked Poles:* No poles having more than one complete twist for every twenty (20) feet in length, no cracked poles and no poles containing large season checks shall be accepted under these specifications.

5—*Crooked Poles:* No poles having a short crook or bend, a crook or bend in tow planes, or a reverse crook or bend shall be accepted under these specifications. The amount of sweep measured between the six (6) foot mark and the top of the pole shall not exeed one (1) inch to every six (6) feet in length.

6—*"Cat Faces":* No poles having "cat faces" unless they are small and perfectly sound, and the poles have an increased diameter at the "cat face," and no poles having "cat faces" near the six (6) foot mark or within ten (10) feet of their tops shall be accepted under these specifications.

7—*Shaved Poles:* No shaved poles shall be accepted under these specifications.

8—*Wind Shakes:* No poles shall have cup shakes (checks in the form of rings) containing heart or star shakes enclosing more than ten (10) percent of the area of the butt.

9—*Butt Rot:* No poles shall have butt rot covering in excess of ten (10) percent of the total area of the butt. The butt rot, if present, must be located close to the center in order that the pole may be accepted.

10—*Knots:* Large knots, if sound and trimmed close, shall not be considered a defect. No pole shall contain hollow or rotten knots.

11—*Miscellaneous Defects*: No poles containing sap rot, woodpecker holes, or plugged holes, and no poles showing evidence of having been eaten by worms, ants or grubs shall be accepted under these specifications.

American Standards Association (A. S. A.) Grade

Material Requirements

1.1—*Specie:* All poles shall be of Western Red Cedar *(Thuja plicata)* cut from live timber.

1.2—*Prohibited Defects:* All poles shall be free from sap rot, cracks, bird holes, plugged holes and injurious checks; from splits, shakes, hollow and decay in the tops; and from damage by marine borers. Nails, spikes and other metal shall not be present in the poles unless specifically authorized by the purchaser.

1.3—*Limited Defects:*

1.31—*Dead Streaks:* All poles shall be free from dead streaks that are wider than one-fourth (¼) of the circumference of the pole at the point of measurement.

1.32—*Decay:* Poles shall be free from decay and from visible evidence of the presence of wood rotting fungi except as permitted under Defective Butts.

1.33—*Defective Butts*: No pole shall have in the butt surface splits or checks extending from one point on the periphery to another point on the periphery and thence upward more than two (2) feet.

No pole shall have hollow heart, the diameter of which exceeds one-third (1/3) the butt diameter or the depth of which exceeds two (2) feet. The depth of hollow heart shall be measured from the butt surface.

Rot is permitted in the butt surface provided the aggregate area of rot and hollow heart does not exceed ten (10) percent of the entire butt surface.

Complete circular shakes may be present on the butt surface provided the diameter of the ring which they follow is not more than one-third (1/3) the diameter of butt.

1.34—*Grain:* No pole shall have more than one (1) complete twist of grain in any twenty (20) feet of length.

1.35—*Insect Damage:* All poles shall be free from insect damage, except that pin holes circular in outline, not more than one-sixteenth (1/16) of an inch in diameter, and not greater in number than fifteen (15) in an area of four (4) square inches, are permitted.

1.36—*Knots:* All poles shall be free from unsound knots. The diameter of any single knot or knot cavity, or the sum of the diameters of all knots and knot cavities in any one (1) foot section, between the top and two (2) feet below the ground line, shall not exceed the limits set up in the following paragraph. Knots and knot cavities one-half (½) of an inch or under in diameter shall be ignored in applying the limitations for sum of diameters.

Table of Measurements, N. E. L. A. Grade

Size	Wgt. Lbs.	Min. Top Circum. (Inches)	Minimum Circum. Six Ft. from Butt (Inches)	Extreme Butt Circum. (Inches)	Maximum Sweep Between Top and 6 Ft. from Butt (Inches)	No. Poles Per Car Min.	No. Poles Per Car Max.
D 20′	235	18½	24	26	3½	210	315
C 20′	310	22	26	28	3½	160	240
B 20′	405	25	28	30	3½	125	185
A 20′	500	28	30	32	3½	100	150
D 25′	310	18½	26	28	4	160	240
C 25′	405	22	28	30	4	125	185
B 25′	500	25	31	33	4	100	150
A 25′	685	28	34	36	4	75	115
D 30′	405	18½	28	30	5	125	185
C 30′	500	22	30	32	5	100	150
B 30′	685	25	34	36	5	75	115
A 30′	780	28	37	39	5	65	100
D 35′	540	18½	30	32	6	90	135
C 35′	660	22	32	34	6	75	115
B 35′	780	25	36	38	6	65	100
A 35′	960	28	40	42	6	50	75
C 40′	780	22	34	36	7	65	100
B 40′	960	25	38	40	7	60	85
A 40′	1200	28	43	45	7	60	75
B 45′	1200	25	40	42	7½	75	90
A 45′	1440	28	45	47	7½	60	85
B 50′	1440	25	42	44	8½	60	85
A 50′	1680	28	47	49	8½	50	75
B 55′	1680	25	44	46	9	50	75
A 55′	1920	28	49	51	9	45	65
B 60′	1920	25	46	48	10	45	65
A 60′	2220	28	52	54	10	40	60
B 65′	2220	25	48	50	11	40	60
A 65′	2640	28	54	56	11	30	45
B 70′	2640	25	50	52	11½	30	45
A 70′	3120	28	55	57	11½	30	40
B 75′	3120	25	52	54	12½	30	40
A 75′	3600	28	56	58	12½	25	35

Poles Longer Than 75′ Can Be Furnished When Required

For Minimum Weights Required for Carload See Page 34

The maximum knot size, for all lengths of poles, of any single knot or knot cavity, shall not exceed a diameter of three (3) inches. The sum of diameters of all knots and knot cavities in any one (1) foot section shall not exceed ten (10) inches.

1.37—*Scars:* No part of a scar shall appear on the upper one-fourth (¼) of the length of a pole or within two (2) feet of the ground line.

Sound scars and cat faces are permitted elsewhere provided the width of the scar or cat face at its widest point is not more than one-fifth (1/5) of the circumference of the pole at that point, nor in any case more than five (5) inches.

1.38—*Shape:* Poles shall be free from short crooks. A pole may have sweep in the section above the ground line subject to the following limitations: (a) Where sweep is in one plane and one direction only, a straight line joining the surface of the pole at the ground line and the edge of the pole at the top shall not be distant from the surface of the pole at any point by an amount greater than one (1) inch for each six (6) feet of length between these points. (b) Where sweep is in two (2) planes (double sweep) or in two (2) directions in one (1) plane (reverse sweep) a straight line connecting the mid-point at the ground line with the mid-point at the top shall not at any intermediate point pass through the external surface of the pole.

A pole may have offset in the section below ground line, provided that the projection of a straight line joining the mid-point at the top and the mid-point at the ground line does not fall outside the butt surface.

Dimensions

2.1—*Length:* Poles under fifty (50) feet in length shall not be over three (3) inches shorter or six (6) inches longer than nominal length. Poles fifty (50) feet or over in length shall not be over six (6) inches shorter or twelve (12) inches longer than nominal length. Length shall be measured between the extreme ends of the pole.

2.2—*Circumference:* Poles shall be classified in accordance with the American Standard Dimensions of Western Red Cedar Poles. This standard gives the minimum allowable circumference at six (6) feet from the butt (except for Classes 8, 9 and 10), and at the top for each length and class of pole listed, but does not preclude the acceptance of poles having greater circumferences at these points of measurement than those shown. The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

Manufacturing Requirements

3.1—*Bark Removal:* Outer bark shall be completely removed from all poles.

3.2—*Sawing:* All poles shall be neatly sawed at the butt and top along a plane which shall not be out of square with the axis of the pole by more than two (2) inches per foot of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than one-twelfth (1/12) of the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.

3.3—*Shaving:* Shaved poles shall not be furnished under these specifications unless specifically called for by the purchaser.

3.4—*Trimming:* Branch stubs, partially overgrown knots and completely overgrown knots rising more than one (1) inch above the pole surface shall be trimmed close. Completely overgrown knots, less than one (1) inch high, need not be trimmed.

Definitions of Terms

4.1—*Fungous Defects:*

4.11—*Decay:* Decay is disintegration of wood substance due to the action of wood-destroying fungi. *Rot* and *Dote* mean the same as *Decay.*

Note—The terms "sound" and "unsound" are used in these specifications to imply that "sound" fiber is unaffected by decay and "unsound" fiber is or has been affected by decay.

4.12—*Hollow Heart:* Hollow heart is a cavity in the heart of the pole resulting from decay.

4.2—*Insect Defects:*

4.21—*Insect Damage:* Insect damage is the result of boring in the poles by insects or their larvae. Scoring or channeling of the pole surface is not classed as insect damage.

4.3—*Timber Defects:*

4.31—*Checks:* Checks are lengthwise separations of the wood in a generally radial direction.

4.32—*Cracks:* Cracks are breaks or fractures across the grain of the wood.

4.33—*Dead Streak:* A dead streak is any portion of the sapwood in which the life process had ended prior to the cutting of the tree.

Note—A dead streak starts from the butt and differs therein from a wound, such as a cat face or scar, where the growth of new wood shows that life processes are still acting to repair the injured part.

4.34—*Scars:* Scars or cat faces are depressions in the surface of the pole, generally elliptical in shape, resulting from wounds where healing has not re-established the normal cross section of the pole.

4.35—*Shakes:* Shakes are separations of the wood, generally parallel with the annual rings.

4.36—*Splits:* Splits are separations between the fibers of the wood extending from surface to surface through the pole.

4.4—*Shape:*

4.41—*Short Crook:* A short crook is a localized deviation from straightness which, within any section of five (5) feet or less in length, is more than one-half (½) the mean diameter of the crooked section.

4.42—*Sweep:* Sweep is the deviation of a pole from straightness.

4.5—*Miscellaneous:*

4.51—*Knot Diameter:* The diameter of a knot is its diameter on the surface of the pole measured in a direction at right angles to the lengthwise axis of the pole.

4.52—*Live Timber:* Live timber is that cut from a tree which was standing and living at the time of cutting.

Bell High Altitude Poles are cut from the finest specie of cedar timber Nature produces—timber that is exceptionally slow in growth, resulting in an unusually close-grained wood with but little sapwood, and from which is produced poles that will carry bigger loads and permit of longer spans than will those taken from any other type of cedar timber. Considering original investment, cost in the line for this type of pole is no greater than for poles from the other wood species; but, spans of greater length, heavier load capacity and longer service life bring the ultimate investment through the use of Bell Poles down to well below the average.

Specifications for Northern White Cedar Poles

N. W. C. A. Grade
Standard or "Woods Run" Poles

(When ordering it is only necessary to specify top diameter and length desired.)

1—*Live Timber:* All poles shall have been cut and manufactured from live green cedar timber. (Note—A test for live timber is to take a very thin shaving from the extreme outside of the pole. If the wood is dead it will show to be very brittle and will break without bending; if the wood is alive, it will bend before it breaks.)

2—*Manufacture:* All poles shall be peeled their entire length, knots trimmed close, and butt and top sawed square.

3—*Lengths:* Any pole may be short of its specified length one-half (½) inch for each five (5) feet of its specified length, or it may be six inches longer than its specified length.

4—*Top Measurements:*

Designated Size	Circumference Green and Watersoaked	Seasoned
4″ top	12½″	12″
5″ top	16″	15″
6″ top	19½″	18½″
7″ top	23″	22″
8″ top	25″	24″

5—*Defects:* (a) Rot—Butt and ring rot combined shall not exceed 5 percent of the area of the butt in all poles five (5) inch top, twenty-five (25) feet long and smaller, and shall not exceed 8 percent of the area of the butt in all poles six (6) inch top, twenty-five (25) feet long and larger.

(b) Top—Tops are to be sound.

(c)—Crook—No pole shall have a short crook or bend, a crook or bend in two planes or a reverse curve. The maximum amount of sweep measured between the ground line and the top shall not be in excess of one (1) inch for each five (5) feet of the length of the pole. The ground line is understood to be four feet from the butt on poles 16′, 18′ and 20′ in length, six feet from butt on poles 25′ and longer. The sweep below the ground line shall not exceed one-half (½) the diameter of the butt.

(d) Miscellaneous Defects—No pole containing sap rot, hollow knots, woodpecker holes, or plugged holes, and no poles showing evidence of having been eaten by ants, worms or grubs shall be accepted, except that poles containing surface worm or grub marks below the ground line may be accepted.

(e) Cat Faces—Small cat faces permitted if sound and not within one (1) foot below or three (3) feet above the ground line and if their distance from the top of the pole is not less than 20 percent of the full length of the pole.

(f) Twist—Winding twist permitted unless unsightly and exaggerated except that there shall not be more than one complete twist for any twenty (20) feet of length.

(g) Maximum Defects—No poles shall contain both the maximum crook and the maximum butt rot.

A. T. & T. or N. E. L. A. Grade

(When ordering it is only necessary to specify the "letter" class and length desired.)

General

The material desired under these specifications consists of the best quality of either seasoned or live green cedar of the dimensions hereinafter specified. Seasoned poles shall have preference over green poles providing they have not been held for seasoning long enough to have developed any of the timber defects hereinafter referred to. All poles shall be reasonably straight, well proportioned from butt to top, shall have both ends squared, the bark peeled and all knots and limbs closely trimmed.

Table of Measurements—A. S. A. Grade
Western Red Cedar Poles

CLASS.....	1	2	3	4	5	6	7	8	9	10
MIN. TOP CIR. (Inches).	27	25	23	21	19	17	15	18	15	12

Length of Pole (Feet)	Ground Line Distance From Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)									
16	3½					23.0	21.5	19.5	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
18	3½			28.5	26.5	24.5	22.5	21.0			
20	4	34.5	32.0	30.0	28.0	25.5	23.5	22.0			
22	4	36.0	33.5	31.5	29.0	27.0	25.0	23.0			
25	5	38.0	35.5	33.0	30.5	28.5	26.0	24.5			
30	5½	41.0	38.5	35.5	33.0	30.5	28.5	26.5			
35	6	43.5	41.0	38.0	35.5	32.5	30.5	28.0			
40	6	46.0	43.5	40.5	37.5	34.5	32.0				
45	6½	48.5	45.5	42.5	39.5	36.5					
50	7	50.5	47.5	44.5	41.0	38.0					
55	7½	52.5	49.5	46.0	42.5	39.5					
60	8	54.5	51.0	47.5	44.0						
65	8½	56.0	52.5	49.0	45.5						
70	9	57.5	54.0	50.5	47.0						
75	9½	59.5	55.5	52.0	48.5						
80	10	61.0	57.0	53.5	49.5						
85	10½	62.5	58.5	54.5							
90	11	63.5	60.0	56.0							

Estimated Weights—A. S. A. Grade
Pounds Per Pole

Cl. No.	Western Cedar	Northern Cedar	Cl. No.	Western Cedar	Northern Cedar	Cl. No.	Western Cedar	Northern Cedar
1-20′	700	720	6-30′	420	420	3-50′	1550	1860
2-20′	600	600	7-30′	350	390	4-50′	1400	1470
3-20′	500	540	8-30′	325	350	5-50′	1300	1380
4-20′	400	350	9-30′	250	275	1-55′	2300	3800
5-20′	300	300	1-35′	1200	1620	2-55′	2000	2960
6-20′	225	230	2-35′	1000	1380	3-55′	1750	2260
7-20′	200	190	3-35′	850	1060	4-55′	1600	1620
8-20′	180	190	4-35′	750	820	5-55′	1600	1560
9-20′	135	130	5-35′	650	720	1-60′	2600	4500
10-20′	100	100	6-35′	650	510	2-60′	2200	3460
1-25′	850	1020	7-35′	470	450	3-60′	2000	2640
2-25′	720	780	8-35′	450	...	4-60′	1900	2200
3-25′	600	600	1-40′	1500	2040	1-65′	3200	....
4-25′	480	515	2-40′	1300	1675	2-65′	2500	....
5-25′	400	420	3-40′	1100	1280	3-65′	2300	....
6-25′	320	300	4-40′	900	1020	4-65′	2200	....
7-25′	250	250	5-40′	800	790	1-70′	3600	....
8-25′	225	250	6-40′	700	740	2-70′	3000	....
9-25′	200	200	1-45′	1800	2640	3-70′	2700	....
10-25′	135	150	2-45′	1550	1970	4-70′	2600	....
1-30′	1000	1320	3-45′	1300	1535	1-75′	4200	....
2-30′	850	1170	4-45′	1150	1215	2-75′	3600	....
3-30′	730	870	5-45′	1000	1080	3-75′	3100	....
4-30′	610	630	1-50′	2000	3200	1-80′	5000	....
5-30′	500	520	2-50′	1800	2640	2-80′	4200	....

Dimensions

The dimensions of the poles shall be in accordance with the following table, the "top" measurement being the circumference at the top of the pole, and the "butt" measurement the circumference six (6) feet from the butt.

When the dimension at the butt is not given the poles shall be reasonably well proportioned throughout their entire length.

The dimension requirement at the six (6) foot mark shall be rigidly followed in all cases. Class A, B and C poles may have top circumferences not more than one-half (½) inch less than those shown in the following table. No pole shall be over six (6) inches longer or three (3) inches shorter than the length for which it is accepted; if any pole is more than six (6) inches longer than is required, it shall be cut back.

Table of Dimen.–A.T.&T. or N.E.L.A. Grade

Lgth. of Poles (Ft.)	Class A Top	Class A Butt	Class B Top	Class B Butt	Class C Top	Class C Butt	Class D Top	Class E Top	Class F Top	Class G Top
20	24″	33″	22″	29″	18¾″	27″	18½″	15½″	15½″	12½″
22	24″	34″	22″	30″	18¾″	28½″	18½″	15½″	15½″	12½″
25	24″	36″	22″	32″	18¾″	30″	18¾″	17¼″	15½″	12½″
30	24″	40″	22″	36″	18¾″	33″	18¾″	18¾″	18¾″	
35	24″	43″	22″	38″	18¾″	36″	18¾″	18¾″	18¾″	
40	24″	47″	22″	43″	18¾″	40″	18¾″	18¾″	18¾″	
45	24″	50″	22″	47″	18¾″	43″	22″	22″	18¾″	
50	24″	53″	22″	50″	18¾″	46″	22″	22″	18¾″	
55	24″	56″	22″	53″	18¾″	49″	22″	22″	18¾″	
60	24″	59″	22″	56″						

Quality of Timber

Dead Poles: The wood of a dead pole is grayish in color. The presence of a black line on the edge of the sapwood (as seen on the butt) also shows that a pole is dead. No dead poles, and no poles having dead streaks covering more than one-quarter (¼) of their surface shall be accepted under these specifications. Poles having dead streaks covering less than one-quarter (¼) of their surface shall have a circumference greater than otherwise required. The increase in circumference shall be sufficient to afford a cross-sectional area of sound wood equivalent to that of sound poles of the same class.

Fire-Killed or River Poles: No dark red or copper colored poles, which when scraped do not show good live timber shall be accepted under these specifications.

Twisted, Checked or Cracked Poles: No poles having more than one complete twist for every twenty feet in length, no cracked poles and no poles containing large season checks will be accepted under these specifications.

Cat Faces: No poles having "cat faces," unless they are small and perfectly sound and the poles have an increased diameter at the "cat face," and no poles having "cat faces" near the six (6) foot mark or within ten (10) feet of their tops shall be accepted under these specifications.

Shaved Poles: No shaved poles shall be accepted under these specifications.

Miscellaneous Defects: No poles containing sap rot, evidence of internal rot as disclosed by a careful examination of all black knots, hollow knots, woodpecker's holes, or plugged holes; and no poles showing evidence of having been eaten by ants, worms or grubs shall be accepted under these specifications except that poles containing worm or grub marks below the six (6) foot mark will be accepted.

Crooked Poles: No poles having a short crook or bend, a crook or bend in two planes or a reverse curve shall be accepted under these specifications. The amount of sweep measured between the six (6) foot mark and the top of the pole, that may be present in poles acceptable under these specifications is shown in the following table:

35-foot poles shall not have a sweep of over 10½″.
40-foot poles shall not have a sweep of over 12″.
45-foot poles shall not have a sweep of over 9″.
50-foot poles shall not have a sweep of over 10″.
55-foot poles shall not have a sweep of over 11″.
60-foot poles shall not have a sweep of over 12″.

Defective Tops: Poles having tops of the required dimensions must have sound tops. Poles having tops one (1) inch or more above the requirements in circumference may have one (1) pipe rot not more than one-half (½) inch in diameter. Poles with double tops or double hearts shall be free from rot where the two parts or hearts join.

Defective Butts: No poles containing ring rot (rot in the form of a complete or partial ring) shall be accepted under these specifications. Poles having hollow hearts may be accepted under the conditions shown in the following table:

Average Diameter of Rot	ADD TO BUTT REQUIREMENTS of 25 and 30 Ft. Poles	of 35, 40 and 45 Ft. Poles	of 50, 55, 60 and 65 Ft. Poles
2 Inches	Nothing	Nothing	Nothing
3 Inches	1 Inch	Nothing	Nothing
4 Inches	2 Inch	Nothing	Nothing
5 Inches	3 Inch	1 Inch	Nothing
6 Inches	4 Inch	2 Inch	1 Inch
7 Inches	Reject	4 Inch	2 Inch
8 Inches	Reject	6 Inch	3 Inch
9 Inches	Reject	Reject	4 Inch
10 Inches	Reject	Reject	5 Inch
11 Inches	Reject	Reject	7 Inch
12 Inches	Reject	Reject	9 Inch
13 Inches	Reject	Reject	Reject

Scattered rot, unless it is near the outside of the pole may be estimated as being the same as heart rot of equal area.

Wind Shakes: Poles with cup shakes (checks in the form of rings) which also have heart or star checks may be considered as equal to poles having hollow hearts of the average diameter of the cup shakes.

Table of Weights—N. W. C. A. Grade

Top	Length	Estimated Weight Per Pole lbs.	Number for Carload Min.	Max.
4″	16′	85	360	550
5″	16′	105	300	500
6″	16′	135	225	400
7″	16′	165	180	300
4″	18′	95	320	520
5″	18′	125	240	400
6″	18′	155	200	325
7″	18′	200	150	250
4″	20′	100	300	500
5″	20′	130	235	400
6″	20′	190	160	260
7″	20′	250	120	200
8″	20′	350	90	130
4″	25′	150	200	325
5″	25′	200	150	250
6″	25′	250	120	200
7″	25′	350	90	150
8″	25′	450	75	125
5″	30′	275	110	185
6″	30′	350	90	150
7″	30′	450	75	125
8″	30′	600	50	90
6″	35′	450	80	120
7″	35′	600	60	90
8″	35′	850	45	65
6″	40′	625	55	85
7″	40′	850	45	65
8″	40′	1100	35	60
6″	45′	900	45	65
7″	45′	1100	35	60
8″	45′	1350	30	55

American Standards Association (A. S. A.) Grade

General

These specifications cover Northern White Cedar Poles. The poles are to be classified in accordance with the American Standard Dimensions of Northern White Cedar Poles, which is a part of these specifications.

Complete detailed instructions shall be given the supplier in all cases where modifications are to be made in these specifications to meet special requirements.

Material Requirements

1.1—*Species:* All poles shall be of northern white cedar *(Thuja occidentalis)* cut from live timber in the territory adjacent to the Great Lakes.

1.2—*Prohibited Defects:* All poles shall be free from sap rot, cracks, bird holes, plugged holes, injurious checks; and from splits, shakes, hollow and decay in the tops. Nails, spikes, and other metal shall not be present in the poles unless specifically authorized by the purchaser.

1.3—*Limited Defects:*

1.31—*Dead Streaks:* All poles shall be free from dead streaks that are wider than one-fourth (¼) of the circumference of the pole at the point of measurement.

1.32—*Decay:* Poles shall be free from decay and from visible evidence of the presence of wood-rotting fungi except as permitted under Defective Butts.

1.33—*Defective Butts:* Decay in the butt within two (2) inches of the surface of the pole shall not exceed one (1) square inch in area. The total area of decay, including hollow heart, in the butt shall not exceed ten (10) percent of the total butt area. The restriction with respect to decay within two (2) inches of the surface of the pole shall not apply to poles which are to be butt treated. Complete circular shakes in the butt may be present provided the area encircled by the shake does not exceed fifteen (15) percent of the total butt area.

1.34—*Grain:* No pole shall have more than one complete twist of grain in any twenty (20) feet of length.

1.35—*Insect Damage:* Insect injury consisting of scoring or channeling in the surface of the pole by insects or their larvae feeding in the cambium and outer sapwood and the holes and shallow galleries associated with the metamorphosis of the common flatheaded borer are permitted. All other forms of insect damage are prohibited.

1.36—*Knots:* All poles shall be free from unsound knots. The diameter of any single knot or knot cavity, or the sum of the diameters of all knots and knot cavities in any one (1) foot section, between the top and two (2) feet below the ground line, shall not exceed the following limits: 35′ length and under, diameter of any single knot or knot cavity 2½″; sum of diameters of all knots and knot cavities in any one foot section 9″. For 40′ length and over, diameter of any single knot or knot cavity 4½″; sum of diameters of all knots and knot cavities in any one foot section 11″.

1.37—*Scars:* No part of a scar shall appear on the upper one-fourth (¼) of the length of a pole or within two (2) feet of the ground line. Sound scars and cat faces are permitted elsewhere provided the width of the scar or cat face at its widest point is not more than one-fifth (1/5) of the circumference of the pole at that point, not in any case more than five (5) inches.

1.38—*Shape:* Poles shall be free from short crooks. A pole may have sweep in the section above the ground line subject to the following limitations: (a) Where sweep is in one (1) plane and one (1) direction only, a straight line joining the surface of the pole at the ground line and the edge of the pole at the top shall not be distant from the surface of the pole at any point by an amount greater than one (1) inch for each four (4) feet of length between these points. (b) Where sweep is in one (1) plane and two (2) directions (reverse sweep) a line joining the mid-point at the ground line and the mid-point at the top shall not at any intermediate point pass through the external surface of the pole. (c) Where sweep is in two (2) planes (double sweep) the sum of the sweeps in the two (2) planes (each sweep being measured as shown on Diagram 1 of the subsidiary drawing on Page 40) shall not be greater than the allowance for sweep in one (1) plane and one (1) direction for a pole of the same length. A pole may have offset in the section below ground line, provided that the projection of a straight line joining the mid-point at the top and the mid-point at the ground line does not fall outside the butt surface.

2.1—*Length:* Poles under fifty (50) feet in length shall not be over three (3) inches shorter or six (6) inches longer than nominal length. Poles fifty (50) feet or over in length shall not be over six (6) inches shorter or twelve (12) inches longer than nominal length. The length shall be measured between extreme ends of pole.

2.2—*Circumference*: Poles shall be classified in accordance with the American Standard Dimensions of Northern White Cedar Poles. This standard gives the minimum allowable circumference at six (6) feet from the butt (except for Classes 8, 9 and 10) and at the top for each length and class of pole listed, but does not preclude the acceptance of poles having greater circumferences at these points of measurement than those shown. The top dimensional requirement shall apply at a point corresponding to the minimum length permitted for the pole.

3.1—*Bark Removal:* Outer bark shall be completely removed from all poles.

3.2—*Sawing:* All poles shall be neatly sawed at the butt and top along a plane which shall not be out of square with the axis of the pole by more than two (2) inches per foot of diameter of the sawed surface. Beveling at the edge of the sawed butt surface not more than one-twelfth (1/12) of the butt diameter in width, or an equivalent area unsymmetrically located, is permitted.

3.3—*Shaving:* Shaved poles shall not be furnished under these specifications, unless specifically called for by the purchaser.

3.4—*Trimming:* Branch stubs, partially overgrown knots, and completely overgrown knots rising more than one (1) inch above the pole surface shall be trimmed close. Completely overgrown knots less than one (1) inch high need not be trimmed.

Table of Measurements—A. S. A. Grade

Northern White Cedar Poles

CLASS.....	1	2	3	4	5	6	7	8	9	10
MIN. TOP CIR. (Inches) .	27	25	23	21	19	17	15	18	15	12

Length of Pole (Feet)	Ground Line Distance From Butt (Feet)	MINIMUM CIRCUMFERENCE AT SIX FEET FROM BUTT (Inches)									
16	3½					26.0	24.0	22.0	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT	NO BUTT REQUIREMENT
18	3½			32.5	30.0	28.0	25.5	23.5			
20	4	39.5	37.0	34.0	31.5	29.0	27.0	25.0			
22	4	41.0	38.5	36.0	33.0	30.5	28.0	26.0			
25	5	43.5	41.0	38.0	35.5	32.5	30.0	28.0			
30	5½	47.5	44.5	41.5	38.5	35.5	32.0	30.5			
35	6	50.5	47.5	44.0	41.0	38.0	35.0	32.5			
40	6	53.5	50.0	46.5	43.5	40.0	37.0				
45	6½	56.0	52.5	49.0	45.5	42.0					

MEASUREMENT OF SWEEP AND SHORT CROOK IN POLES

DIAGRAM 1.—MEASUREMENT OF SWEEP IN ONE PLANE AND ONE DIRECTION.

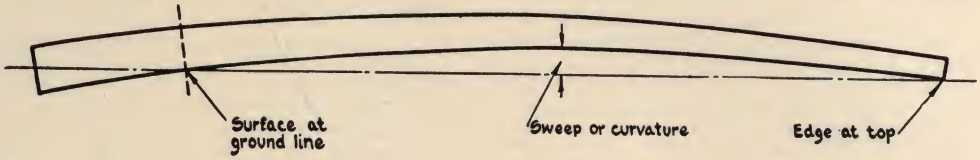
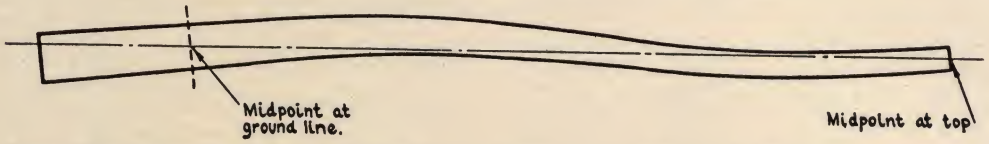
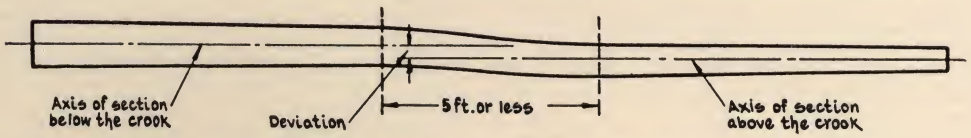


DIAGRAM 2.—MEASUREMENT OF SWEEP IN TWO PLANES (DOUBLE SWEEP) OR IN TWO DIRECTIONS IN ONE PLANE (REVERSE SWEEP).

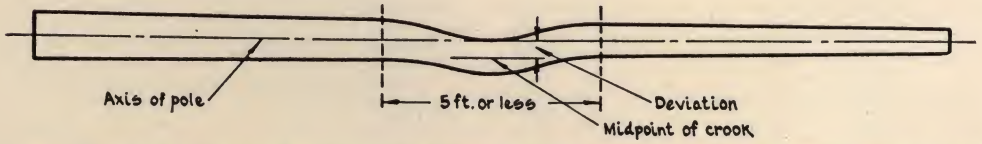


NOTE: This diagram applies to the measurement of double sweep in Western Red Cedar and Southern Pine poles. For measurement of double sweep in Northern White Cedar and Chestnut poles, see text.

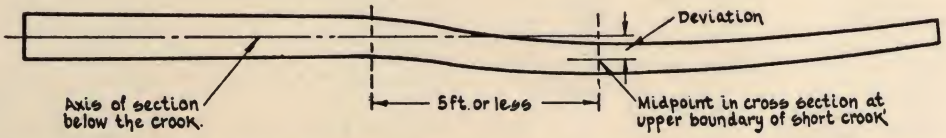
DIAGRAM 3.—MEASUREMENT OF SHORT CROOK (THREE CASES SHOWN).



CASE 1: WHERE THE REFERENCE AXES ARE APPROXIMATELY PARALLEL.



CASE 2: WHERE AXES OF SECTIONS ABOVE AND BELOW THE CROOK COINCIDE OR ARE PRACTICALLY COINCIDENT.



CASE 3: WHERE AXIS OF SECTION ABOVE SHORT CROOK IS NOT PARALLEL OR COINCIDENT WITH AXIS BELOW THE CROOK.

NOTE: The three cases shown under Diagram 3 are typical and are intended to establish the principle of measuring short crooks. There may be other cases not exactly like those illustrated.

Serving A Large Field

The Bell Lumber & Pole Company is unusually proud of the large number of satisfied Bell Pole users in almost every state in the Union and through Canada. . . . Bell Poles, Western Red Cedar and Northern White Cedar, have gone into the Transmission and Distribution lines of hundreds of utilities in both the Electric Power and Telephone fields. Among a few of the largest properties where Bell Poles have gone into line construction are:

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Byllesby Engrg. & Mgmt. Corp., Various States
Consumers Power Company, Michigan
Central Maine Power Company, Maine
Connecticut Power Company, Connecticut
Duquesne Light Company, Pennsylvania
Dayton Power & Light Co., Ohio
Erie County Electric Co., Pennsylvania
Eastern Minnesota Pr. Co., Minnesota
East York Hydro-Elec. System, Ontario
Ft. Smith Light & Traction Co., Arkansas
Hartford Electric Light Co., Connecticut
Illinois Northern Utilities Co., Illinois
Iowa-Nebraska Lt. & Pr. Co., Nebraska
Jamestown Public Utilities, New York
Kansas City Lt. & Pr. Co., Missouri
Lake Superior District Power Co., Wisconsin
Madison Gas & Elec. Co., Wisconsin
Michigan Gas & Elec. Co., Michigan
Monongahela-West Penn. Pr. Co., W. Virginia
Missouri Public Service Co., Missouri
Montreal Lt. Ht. & Pr. Co., Quebec
Northern States Power Co., Minnesota
Northern Indiana Pub. Serv. Co., Indiana
New York Pr. & Lt. Corpn., New York
Northwestern Pub. Service, South Dakota
Nova Scotia Lt. & Pr. Co., Nova Scotia
Oklahoma Gas & Elec. Co., Oklahoma
Philadelphia Electric Co., Pennsylvania
Public Service Co., Nor. Ill., Illinois
Panhandle Pr. & Lt. Co., Texas
Peoples Power Company, Illinois
Red River Power Company, North Dakota
Sherrard Power System, Illinois
Sioux City Gas & Elec. Co., Iowa
Shawinigan Wtr. & Pr. Co., Quebec
Trenton Public Utilities, New York
Union Elec. Lt., Ht. & Pr. Co., Missouri
Western United Gas & Elec. Co., Illinois
Wisconsin Pub. Service Corpn., Wisconsin
Westchester Lighting Company, New York
Wisconsin Gas & Elec. Co., Wisconsin
Wisconsin Pr. & Lt. Co., Wisconsin
Commonwealth Telo. Corpn., Wisconsin
Marne & Elkhorn Telo. Co., Iowa
Manitoba Telephone System, Manitoba
Mutual Telephone Company, Iowa
Newark Telephone Corpn., Ohio
Peoples Telephone Company, Wisconsin
Pt. Creek Farmers Telo. Co., Iowa
Pike County Telo. Company, Illinois
Pennsylvania Telo. Corpn., Pennsylvania
South Penn Telo. Corpn., Pennsylvania
Tri-State Telo. & Tele. Co., Minnesota
Up-State Telo. Corpn., New York
Northwestern Bell Telephone Co.
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